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INDUSTRIAL CONDITIONS AND THE MONEY MARKETS.

By Maurice L. Muhleman.

TO the close observer of events the fact that the world's money markets exercise a most potent influence upon industrial development is well known. The view held by many of our fellow-countrymen that the transactions of the exchanges, and more especially those of the stock exchanges, are merely speculative or gambling operations, and have therefore only a sinister influence, is a superficial one; for beneath the surface it will be found that actual values are there determined as accurately as the assayer discovers the quantity of precious metal in a mass of ore subjected to his processes.

The money markets, as a whole, are the places where *credits* are ascertained and exchanged; and, although the movements are not always governed by the highest motives,—rarely, if ever, by sentimental ones,—the net results will generally be found to have been based upon facts affecting values, considered from the purely economic point of view. This does not imply that the gambling element is entirely without influence, but that this influence, being of a temporary character only, is by no means the controlling one; and that in the long run it plays but an unimportant part in the determinations of the great financiers and the trusted bankers who are placed—by investors—in the position of arbiters of the destinies of industrial enterprises. Stock-exchange prices themselves do not affect the value or the prospects of an undertaking: they merely constitute the monetary index of the conditions which *do* affect such prospects.

The men of the money markets, as dealers in credits, are called upon to provide and do provide—or obtain—capital for the promotion

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of enterprises; and it is upon their judgment that the investor ordinarily depends. Nor is the opinion of these men (among whom must be included bankers, officers of banks and trust companies, brokers, and exchange dealers) formed arbitrarily or capriciously, any more than is the discrimination of the local grocer in extending credit to the sober, industrious mechanic rather than to the idle inebriate.

Inasmuch as no extended industrial development is possible unless the promoters are able to command the necessary capital at cheap, or certainly at reasonable, rates, the beginning of new enterprises and the continuance of such as have already been begun are dependent upon the conditions governing the money markets for the time being. When capital is scarce and interest rates abnormally high, loans or investments cannot be obtained at profitable rates even for the most promising undertakings. Industries requiring financial support will consequently languish, and the spirit of progress meets with little encouragement. The same results follow upon conditions almost exactly the reverse,—an abundance of money and abnormally low rates of interest,—when general credit has been impaired by circumstances arousing suspicion. These conditions have existed since 1890.

During the years immediately preceding 1890 we witnessed an unprecedented "opening up" of new sections of the world and the inception of public works upon a large scale. Under the apparent lead of the great London banking house of Baring Brothers & Co., capital, not only from Great Britain, but from all of the loaning nations of Europe, had been freely advanced to promote some of the most gigantic enterprises of modern times. The usual number of "wild cat" undertakings also received assistance, and assumed sufficiently great proportions to cause the force of the reaction which followed in 1890 to shake international credit to its foundations.

The credit institutions of Europe began almost immediately to draw in their monetary forces, and capitalists, fearful of further losses, preferred to submit to serious reductions in their incomes and even to allow funds to lie idle. The cash holdings of the issue banks of Europe steadily increased, until at the end of 1895 the sums so held were greater by nearly $650,000,000 than at the end of 1890, without a corresponding increase in their loans or their note issues; in a number of institutions the deposits practically doubled during the period. The decrease in the amount of new capital placed in London was over $2,000,000,000 for the years 1891-95 compared with 1886-90, and the accumulations of idle capital reduced the interest rates to less than one per cent. in 1895. We have, therefore, conclusive evidence that the investing public (the owners of capital) was and still is unwilling to advance money to any considerable

extent compared with former years. No obligations which were in the slightest degree under the cloud of distrust could be disposed of at anything like reasonable rates. On the other hand, a few securities of the very highest character appreciated in value to a remarkable degree; thus the British Consols, bearing interest at the rate of only 2¾ per cent., and which in 1890 sold as low as 97, rose to 107 at the close of 1895, and have since been quoted at 110. The extent to which the absence of ordinary credit in the money markets affected business and the world's industrial development it is impossible to estimate, even approximately.

When it is borne in mind that the five years under consideration (1891-1895) cover a period during which the world produced more gold than in any preceding period of five years in its history, thus affording a greater additional supply of the material upon which capital is based than was ever before available for industrial uses; and when we recall that, contemporaneously with the conditions already referred to (and directly traceable to them), an enormous shrinkage of values and incomes took place, while the burden of taxation was absolutely increased rather than diminished,—the tremendous loss to the world and to civilization through the financial earthquake of 1890 may be appreciated to a perceptible degree, although never measured. The suspicion generated by the losses of that year gave rise to a distrust which time alone can allay; the absence of normal credit was all but universal. The men of the money markets were powerless, and their losses were also great, since the profits of the overwhelming majority of them depend chiefly upon an active conversion and employment of capital at reasonable rates, with abundant credit for all legitimate undertakings.

In the United States the conditions during the two years preceding 1890 were such that the effect of the upheaval in Europe and elsewhere was not felt so severely at once. Under the existing political system our industrial organization is to a considerable extent independent of, and unaffected by, the fluctuations of prosperity in other countries; but even these protected industries could not for any length of time remain uninfluenced by the continued stagnation in the monetary world abroad.

To a country whose exports consist chiefly of the products of the soil and the mines, and whose growth therefore depends to a great degree upon the settlement of new sections and their development through the introduction of transportation facilities and improved machinery of all kinds, surplus and unemployed capital is absolutely indispensable. But these very conditions render it impossible for our own people to provide cheap capital in ample volume, and hence we

have for many years been depending upon foreign countries, principally Great Britain, France, and Germany, for a very large part of the necessary funds to continue our industrial development.

When, therefore, soon after 1890, foreign funds were not so readily procured, our development was checked. This became manifest first in the decrease in railway construction; and necessarily the industries dependent on the demand for material and motive power which an active extension of transportation facilities creates were soon affected. This in turn reacted upon other trades, until finally the wave must have reached the farthest hamlet of the country. Consumption of material and commodities became restricted, and for a time it appeared as if the country had been overproducing enormously.

The effect upon general business can not be illustrated better than by comparing the volume of transactions of all the clearing-houses of the United States for the three years last past, with that for the three preceding ones; side by side are given the amounts of *new* securities (both bonds and stocks) listed in New York.

Year.	Clearings.	New Securities.	Year.	Clearings.	New Securities.
		(In millions of dollars.)			
1890	60.623	275	1893	54.323	244
1891	56.718	288	1894	45.686	*121
1892	62.109	360	1895	53.348	*170
Total,	179.460	923	Total,	153,357	535
Average,	59.820	308	Average,	51.119	178

The average annual decrease of business, as thus shown, is over $8,700,000,000, while the average annual decrease in the bonds and shares placed on sale, representing new enterprises, was $130,000,000. It will be observed that, while the year 1891 showed some falling off in business, the actual settled shrinkage did not take place until 1893; in fact, in many respects the year 1892 may be regarded as the one of the greatest expansion, showing conclusively that the country had to that date apparently withstood the effects of the shock under which the rest of the world had been struggling along. Immigration to the United States from Europe was greater in 1892 than ever before, and did not diminish until after the spring of 1893.

Before proceeding with the consideration of our home affairs during this period, it will prove useful to examine our international relations. An element peculiar to this country existed to add to the general distrust manifested in the money centers of Europe. This was in great measure founded upon a failure on the part of foreigners to fully comprehend our heterogeneous currency system, which, it may be

* After deducting for United States loans, 1894, $100,000,000, and 1895, $63,000,000.

said, the mass of our own people take more upon faith than by reason of a clear understanding. We have an unbounded faith in the absolute financial integrity of the United States, and anything in the form of money bearing the federal stamp is accepted freely by us. But to the foreigner—especially the money-loaning foreigner—this sentiment counts but little. Being a question of credit, pure and simple, failure to understand breeds distrust. Accordingly, not only did we fail to obtain further advances of money to promote our enterprises, but much of the capital already invested here was from time to time called back. The total excess of exports over imports of merchandise and silver for 1881-1895 was $627,000,000; and the excess of gold exports amounted to $251,000,000. In return we received a mass of our obligations, for which a market had to be found here, necessarily causing a steady decline in the prices of such bonds and shares as had enjoyed a foreign lodgment.

Apparently we were strong enough financially to endure the strain thus put upon us as a nation up to the end of 1892. But eventually it became too great, and general disaster was only partially averted by the skilful handling of all of our available forces. Money was hoarded in 1893, and a severe stringency followed.

The effect of this apparently enormous withdrawal of capital from ordinary use inevitably operated disastrously upon the entire industrial organization, and, reacting, restricted the demand for capital, since all gainful occupations are interdependent. The cessation of development threw certain kinds of labor out of employment, reducing their capacity for consumption, including under that term all that enters into the maintenance of life. This in turn served to diminish the need for other labor, and accordingly a series of changes took place which it is impossible to illustrate fully by means of existing statistics. We are able, however, to indicate a few points in the table below.

SOME INDUSTRIAL STATISTICS, UNITED STATES, 1890 TO 1895.

Year.	Railways.					Pig Iron product thou. tons.	Deposits in Savings Banks.† millions.
	Miles built.	Earnings millions.	Expenses millions.	Freight miln. tons.	Employees thousands.		
1890	5626	1098	754	691	749	9203	1525
1891	4620	1138	782	704	784	8280	1623
1892	4584	1205	846	749	821	9157	1713
1893	2789	1223	858	757	874	7124	1785
1894	2157	1080	758	675	780	6657	1748
*1895	1800	1155	803	710	810	9446	1811

*Statistics of Railways 1895 estimated. †Given for middle of year.

Railway construction, being largely aided by foreign capital, showed the effects earlier than other industries; and the earnings of the trans-

portation companies did not diminish until 1893,—a year later than would have been the case but for the World's Fair. The expenses of railways fell off from 1893 to 1894 fully $100,000,000, and the services of 94,000 employees were dispensed with. The difference between the railway construction of 1890 and that of 1895 represents a sum of $230,000,000, and the decrease in the product of pig iron in 1894 compared with 1890 meant an approximate loss of nearly $30,000,000 in this single branch of the industry. If the manufactures of the entire nation suffered a similar diminution, the value of the product decreased $2,600,000,000, with a loss in wages of fully $600,000,000. It is not surprising, therefore, to find that the savings of the frugal ones increased only $72,000,000 in 1892-3 and were trenched upon to the extent of $37,000,000 in 1893-4, instead of being increased by $98,000,000 as in 1890-1, or by $90,000,000 as in 1891-2. Had the ratio of increase during the latter period been maintained, the amount of these deposits in 1895 would have been $2,073,000,000, or $262,000,000 greater than was actually the case. After 1893, on the other hand, the deposits in the discount banks increased rapidly, and money was loaned upon call at rates as low as ½ per cent.

Let us now examine the effect upon the market price of shares of the series of disturbances, foreign and domestic, which we have suffered since 1890. We have seen that two important forces operated to depress these prices,—the "unloading" of securities on the part of foreign holders, and the stagnation in general business which reduced the dividend-paying capacity of the corporations whose shares are bought and sold in open market. The depression thus caused necessarily added to the already existing distrust.

A review of the course in the market of the shares of twenty representative corporations, chiefly railways, gives the following average prices for the end of each year:

1890.	1891.	1892.	1893.	1894.	1895.
60.21	71.22	66.50	50.48	50.77	51.54

These results show a decline since 1891 of more than 20 points, without strong symptoms of recovery.

A more detailed account of the fluctuations is shown in the exhibit below, giving the general course of average prices between certain dates of the same twenty active, representative shares.*

1890.	1891.	1892.	1893.	1894.	1895.
Rising	Rising	Rising	Rising	Rising	Falling
Jan. 73.35	April 69.00	March 75.68	Jan. 70.87	April 57.27	March 48.75

* From the *Wall Street Journal.*

Falling	Falling	Falling	Falling	Falling	Rising
March 70.65	July 61.50	Sept. 67.97	March 62.86	Aug. 51.45	Sept. 63.77
Rising	Rising	Rising	Rising	Rising	Falling
May 78.03	Sept. 73.21	Oct. 71.43	April 66.25	Aug. 57.60	Sept. 59.66
Falling	Falling	Falling	Falling	Falling	Rising
Nov. 59.25	Nov. 67.52	Dec. 66.50	July 43.47	Oct. 51.24	Sept. 62.50
Rising	Rising		Rising	Rising	Falling
Nov. 64.03	Dec. 71.22		Oct. 57.82	Nov. 54.78	Dec. 48.56
Falling			Falling	Falling	Rising
Dec. 58.10			Dec. 50.48	Dec. 50.77	Dec. 52.76
Rising					Falling
Dec. 60.21					Dec. 51.54

These figures show the extremes nearly 35 points apart, the highest prices having prevailed in the spring of 1890 (78.03) and of 1892 (75.68); the lowest price (43.47) was in the summer of 1893, but for a short period the declines in 1895 carried the prices below 50.

The currency problem has been so fully treated in previous numbers of this magazine that reference to it has been purposely omitted here; and although the preceding pages give the reader only an imperfect view of the effects of the revulsion from which we are now recovering, sufficient has been shown to make it clear that there can be no healthy industrial development without a sound system and a relatively stable money market; that the results of a shaking of confidence are sure to react upon all enterprises, and, by affecting labor and the consuming power of the mass of the population, touch even the business of the smallest storekeeper and the most insignificant trade-worker.

Spasmodic and short-lived disturbances are rarely far-reaching in their influences; indeed, these may be expected during the most serene periods; but they pass away without injury to the industrial organization. A continued fall and general depression of the share market, however, is an indication of an approaching economic storm as surely as the depression registered by the barometer portends meteorological disturbance. The instrument of the meteorologist is not more sensitive than the share-market, and, just as the official forecaster of fair or foul weather examines his instruments and the reports which reach him of conditions elsewhere, so the men of the money markets and investors of capital look for the cause of the eccentricity of the share-list and prepare themselves accordingly,—conserving their forces, but, withal, endeavoring to the utmost to maintain the *general credit* which is the very life-blood of the industrial organism.

And, finally, what is the teaching of all this costly and varied experience? Plainly this: that to insure conditions of stable and healthy prosperity we must so order our currency system and so manage our great industrial enterprises that both will command the entire confidence of both home and foreign investors.

RAILROAD CORPORATIONS IN PRACTICAL POLITICS.

By Cy Warman.

NO branch of business, no profession, trade, or calling,—has attracted a more intelligent lot of men than are now engaged in the management of American railroads. Railroading is fascinating work and pays well. With a salary ranging from ten to fifty thousand dollars a year; with a private car, stocked at the company's expense, to say nothing of countless other perquisites,—the president of an American railroad has in some respects a better post than the president of the United States. He lives like a prince at home, and, if he is compelled to patronize a hotel, he always goes to the best to be found. He is respected even where he is known, and, if he happens to be an orator, he is invited out, and big banquets are spread in his honor. In short, the American railroad president is a great man, and his assistants are equally great—only they have not yet been promoted.

Accepting all this as true, it is hard to reconcile the fact that these brilliant men are, in one respect, the easiest game this glorious country affords. They are the especial prey of the professional politician, and do more to make the existence of the political shell man possible than any other class of citizens. They begin by giving the politician a pass, and end, in more cases than one, by assigning him a private car. It matters little what political party the professor belongs to; politicians, like whiskey, are much the same the world over, and produce the same general effect. If, in what follows here, reference is made to any political party, it will be only to prove something, and should not count for or against the party mentioned. Not a few railroad managers are beginning to see the folly of mixing in political affairs, and are gradually letting go. It is not the public alone, upon which every railroad must depend for support, that becomes an enemy of the corporation; in many instances the very employees, who ought to be loyal, and naturally are, are found cursing the company that gives them employment, because their rights and liberties as American citizens are interfered with.

The mixing of the management of a great railroad with the politics of the section through which it passes is sure to bring embarrassment to the corporation, and equally sure to bring political ruin to the party in the mix. A few instances will confirm this statement.

Until a few years ago the Republican party presided over the destinies of Nebraska. The Union Pacific railway company and the Burlington & Missouri railroad company went into politics, and the Republican party went out. At first these rival corporations were arrayed the one against the other; but they soon found that the people were against both, and then they united to control the State legislature, to elect congressmen, and dictate to the people who should go to the United States senate from the corn country. For some years they were successful, or thought they were, but with that success there came a world of work and worry,—embarrassing situations and no end of annoyances for the railroad officials whose duty it was to "take care of" the companies' friends. Among these friends were the professional politicians and all the heelers and helpers, vote-winners and ward-workers, of every flag-station along the line of either of the great roads. It required a press to print, and a pass-clerk to sign, passes for "our friends" and the friends of our friends. All this time the people who were trying honestly to make a living by growing corn or feeding cattle were becoming anti-monopolists. The feeling against the corporations grew stronger and stronger every year. Men who were placed in power by corporations were actually afraid to befriend the companies, so intense was the feeling against them and the railroads.

At North Platte a boiler-maker was mayor, and every member of the city council was in the employ of the Union Pacific railway company, and yet the company was continually harassed by this little insignificant municipality. A puddle of water on railroad land was declared a public nuisance, and no right-of-way could be secured across a street or alley. An officer of the company visited the town, met the mayor (who came from the shop to meet him, and whose time went right on), and asked why the company could not have as fair treatment as any other property-holder.

"Now, upon your honor," said the superintendent, "isn't this right and fair? Isn't that wrong and unjust?"

"Yes," said the mayor, "what you ask is perfectly fair; but we, as employees of the company, can't afford to vote that way, for the people say we are slaves of the corporations, and we have decided to stay with the people, even if we lose our places with the road."

The superintendent assured him that none of the men would be discharged; but the company took good care that no employees were elected to office, at least by the company's aid, at the following election, and, when another mayor and a new lot of aldermen came in, the railway company had no more trouble at North Platte.

A few years ago Colorado was Republican by thirty thousand. If

a man was able to secure a nomination on the Republican ticket, he was sure to be elected. Colorado politics became shady. The people were beginning to get together in little knots on street corners, and kick. The politicians grew uneasy as the people showed signs of being "on." The corporations of Denver were told that, unless a lot of money could be poured into the Republican State central committee's fund, the glorious State of Colorado would be lost. The corporations came down handsomely, and the ticket was elected. When the legislature met, there was a great deal of talk about anti-railroad legislation. Some bills were introduced, which, if they had become laws, would surely have done the railroad and other interests great injustice. The corporations had prostituted themselves before the election,—signified their willingness to be worked,—and now the chief "flim-flam" of the political "buncoes" (who was himself, no doubt, the author of the proposed anti-railroad bill) came breathlessly to the corporations, saying: "We are lost, unless we can get money at once."

"How much?"

"Ninety-two thousand dollars."

He got the money. One company put up forty thousand dollars. This money all went to deepen the hue of Denver, and, when it came to a "show-down," the gentleman who was "looking after the interest of the railroads" was unable to control a single vote. In the meantime so much had been done that it looked as though the objectionable bill would pass. The situation was so serious that the substantial business men of Denver, regardless of party, and without money or price, went into the fight and defeated the bill.

When the time for another election rolled round, and the Republican State committee went down to the Union depot, they found a new man there—the same who, a few years ago, went to North Platte to see the mayor.

"Being a Republican," the spokesman began, "I presume you are with us politically?"

"You bet!" was the brief reply.

"Ah," said the politician, with a happy smile, "we can always rely upon the Union Pacific."

"Well," said the general superintendent, "if you are speaking of the company and its employees, I can't answer. I only speak for myself."

"Of course, yes—but—but you will instruct your employees to vote the Republican ticket,—that it is for the company's interest,—will you not?"

"I will not, and, if any officer or foreman in the employ of this

company dares insult the employees with such a proposition, I'll see that he has plenty of time to devote to politics in the future."

The committee retired.

It should be remembered that the story above related—the $92,000 story—was still fresh in the minds of the people. They were as weary of being ruled by the corporations as the corporations were of being ruled by the politicians, and about thirty thousand good honest Republicans voted "the way they thought." The corporations found themselves confronted by a Populist governor and a legislature that was not Republican, but it came cheap. They had paid nothing for its election, and there was no bad feeling. On the contrary, Democrats and Populists felt themselves indebted to the corporations for the first fair, square, open, and honest election Colorado had seen in many years.

When the legislature met, a committee from both houses—self-appointed, perhaps—waited upon the gentlemen whose experience I have been relating, and whose companies had contributed the ninety-two thousand dollars above referred to.

"The railroad companies," began the visitors, "have been in the habit of spending vast sums of money in the legislature, for which, as you must know, they have received no benefits. We are not here to offer ourselves to the corporations; on the contrary, we wish to assure you that no lobbyist can dictate to this legislature; but, if you are bound to spend money, give it to us, and we will guarantee you fair treatment. You have claimed in interviews that all the railroads asked was the same treatment accorded individuals or other corporations, and that you can be reasonably sure of; only we object to politicians receiving money for our votes."

"Gentlemen," said one of the railroad men, "if twenty-five cents was all that was needed to defeat or pass a bill in this legislature, I could not possibly get the money, for we have done with politics. We want no special or class legislation, and, if you pass a law detrimental to our interests and the business interests of Colorado, we will beat you in the courts."

This committee was of all parties, and one of its members crossed over to a general manager, held out his hand, and said:

"If you mean that, we're with you; if you don't mean it, there will be trouble."

The railroad men assured them that they meant it, and the legislature sat down unfettered.

Colorado had for years been burdened with a "railroad commissioner," who did the State no good and the railroads no harm, save that he annoyed the officials. This semi-Populist, anti-monopolist

legislature put out his light, stopped his pay, and let him go. Governor Waite vetoed the bill which abolished the railroad commissioner, and the legislature passed it over his veto.

These are not romances, but facts.

"The best part of my life since the war has been spent between corporations and politicians, and my experience is that the moment a corporation thinks it has control of the politics of a section or a county, that moment it is hopelessly in the hands of the politicians." Such was the declaration of a fearless official, whose company has done much to corrupt the politics of the west, but which, at last, in self-defence has solved the problem.

A Denver company, owning and operating one of the most perfect and complete street-railway systems in existence, is almost hopelessly entangled in the political cobweb. It has dabbled in politics to such an extent, and has become such a power, that it must always be taken into account by those who aspire to office. Here comes the blighting influence. A candidate must be elected either with or without the aid of the corporations; but from the moment he consults them he is simply an instrument in the hands of the corporation. This company has done a great deal for the city, and ought to have the good wishes of all the people, but it has not. One-half of the population—those who happen to be of the same political faith—say nothing, while the other half heap upon the heads of this company's officials bitter curses every day. Of course, this condition of affairs argues nothing against the political party whose mask the corporation wears. Such a corporation will invariably favor the political party in power in the State in which it does business.

Not long ago a national bank of Denver, which would unquestionably be doing business to-day if its officers had not endeavored to control certain politicians who had the placing of public money, closed its doors. These cases are cited because the writer knows of them. The situation in any other part of the United States is, no doubt, as bad as that of the west.

Probably no corporation in the country has been so deep in politics or suffered more from that source than the Southern Pacific railway company. It began by electing the State legislature and ended by controlling, or trying to control, United States senators and supreme court judges. It has succeeded sufficiently to earn the undying hatred of the whole population of California. It is doubtless accused of much of which it is innocent; but, when a community has learned to hate a thing as that community hates the Southern Pacific, there is no stopping it. Visit California, and you will find the present officials of the Southern Pacific as genial and obliging as those of

any other railroad; yet they are actually despised personally because of their connection with this unpopular company.

Well-informed railroad men are of the opinion that the differences between the Union Pacific and the government could be adjusted without the least bit of trouble, if the Southern Pacific could be left out of the question; but, the moment the least concession is hinted at in favor of the California company, the people are up in arms.

After having controlled the politics of the Pacific coast for years, this great corporation is tottering under the load. The people of California charge that this company has not been content with controlling the greater officials, but has made its demoralizing influence felt in the election of a justice of the peace or a county constable. It has not confined itself to the operation of the Southern Pacific road, but has engaged in other enterprises, until to-day, it is said, a stranger cannot enter San Francisco without paying tribute to this corporation going and coming. While in the city, if you hire a carriage, ride in a street car, and in many cases dine at a café or attend a theater, you are paying something to the despised corporation.

Now the people are crying for a change. They long to be free from the corporation, and the corporation is doubtless as anxious to be free from the politicians it has helped to create; for it is only a question of time when they will wear out the stoutest corporation in existence. While Stanford lived, his personal popularity with the company's employees worked as a sort of leaven to the public, but now that leaven has passed away. Where the farmers and villagers are not oppressed and overcharged, they think they are, and the result is that never a dollar's worth of business is given to the railroad company where it can possibly be avoided. It would be interesting to know how much money the Southern Pacific railway company has received in the past twenty years that could be properly reckoned as the result of excessive and unreasonable freight and passenger rates. It would be equally interesting to know what the political herd has cost the company, directly and indirectly, during the same period, and to strike a balance.

Of course, all the stories told by the advocates of State ownership of railroads and by angered citizens cannot be taken as true. Still, the fact remains that the Southern Pacific railway company is in politics, and in so deep that it seems impossible for it to get out; but it *will* get out, and it will never be able to sleep o'-nights until it *is* out.

[Of course, railroad corporations have not been blameless. It is idle to pretend that they have. All over the country, and even in the lobbies of the national legislature, there have been dickerings and

deals, more or less scandalous, between the railroads and the political managers. As to new charters, land grants, bond subsidies, etc., the scandals have been greatest in the newer regions, where, twenty-five years ago, railroad building was beginning, and there was opportunity—now passed forever—to secure valuable privileges. Events like the Credit Mobilier *exposé* and intrigues of a similar character have been unfortunately too frequent; but they cannot occur again, because the conditions making them have passed away. In the west, however,—indeed everywhere,—the roads have been in constant contact with legislation,—in hope of favorable, in dread of antagonistic, measures,—and there are always questions arising as to charter amendments, privileges, restrictions, rights-of-way, and passenger and freight rates. Legislation under these heads can hardly fail to involve "practical politics," and the railroad companies, willingly or unwillingly and almost helplessly, have been entangled in the mesh.

But, when the public accuses the railroads, it commonly fails to see that, taking the whole range of railroad politics into consideration, there are two sides to the case. While no doubt the roads are often to blame for instigating dubious methods, it more frequently happens that the railroad officials have had no choice, even although aiming at entirely justifiable ends or simply seeking to protect their interests against fanatical or blackmailing persecution, except to enter into the political field. Every State party boss, every little clique of professional politicians, can at will levy tribute upon the roads; and, as to the morality of this, the roads are considered legitimate game. If open threats are not used, there is an equally effective, though tacit, intimidation, backed by the prospect of adverse legislation, from which no corporation, however strong, is ever exempt; so that the railroad managers are kept in a chronic state of anxiety as to what is next going to be done to them. And, on the other hand, when something positive is needed,—as, for example, extensions of way,—the corporations feel that they must make friends either with the stronger party or with all possibly opposing parties. So, whether for self-preservation or for the sake of concessions, the roads are equally involved. Indeed, this has gone so far that it is notorious that some companies, like industrial corporations of other kinds, have contributed (and heavily) to *both* contesting parties in a general election. Does anyone suppose that this is done willingly, or as a matter of sound economy?

The causes of the trouble lie at the doors both of the corporations and the politicians. Which are most culpable is an intricate question. It is not always easy to say whence comes the initial impulse,—whether from the roads to the politicians or from the politicians to the

roads. But, on the whole and in view of the significant fact that the day of great land grants and sweeping charters has passed, and the other great fact that the corporations are now on the defensive, it may fairly be asserted that the railroads are more sinned against than sinning. The fault is largely due to the prevailing low tone of politics, or, at least, of that variety known as "practical."

Railroad managers would like to know where to seek a remedy for the existing state of things, which is unsatisfactory in every respect, not only leading to a constant drain upon their financial resources, but bringing them, often undeservedly, under public censure. As has been shown by a very few out of the endless possible illustrations, when the railroads go into politics they not merely fail in their objects, but often actually defeat themselves. Have they not tried this long enough? Would it not be better to take a determined stand on a new policy, beginning with a reformation of the pass and favor system and an impartial refusal to contribute—as corporations—to any political tax-gatherer, or to in any way, directly or indirectly, influence their employees' votes, or to interfere in the selection and election of candidates? The time has come when thinking men understand the awkward position of the railroads, and a straightforward course would secure public recognition and do much toward removing popular antagonism.—THE EDITOR.]

PUMP IRRIGATION ON THE GREAT PLAINS.

By H. V. Hinckley.

THE entry of the irrigator upon the immense plains of the West —those billion acres once described in school-books as the "Great American Desert"—is more even than an advance in the westward march of empire; it is a long step forward toward the attainment of an exact science of agriculture. Of what avail is the farmer's tripartite labor of planning, planting, and cultivating, unless it be crowned, and finished four-square and perfect, by the glad reaping and gathering into barns? And where is the non-irrigating farmer who has not learned, time and again, the burning lesson that his study and toil were of no avail when the land failed to receive the desired "water of the rain of heaven"? Where is the agriculturist who has not learned that an average annual rain-fall of forty inches will not vivify his scorching acres, if only three inches of the forty fall between June and October? What gardener or fruit-grower does not remember season upon season when he would gladly have paid five dollars an acre—yes, ten dollars or even more—to secure the water which the clouds withheld?

Nor is the disadvantage limited even to the occasional or frequent loss of a crop. It is deeper and farther-reaching still; for the tiller of the soil who depends on natural climatic conditions must perforce confine himself to raising those crops which are least injured by periods of unfavorable weather, and, as a result, we find a vast proportion of the available acreage of our country given over to wheat and corn, from which $12 to $15 per acre is a fair return to the grower. The man who can so control his environment as to grow alfalfa, and feed it, can readily raise the returns to $20 to $50 per acre: he who, through still more favorable conditions, can raise vegetables or fruit with certainty and market them with facility can increase his income to $100 or $200 per acre, or even more.

It is the certainty of the crops which is the most important element in the problem of profitable farming, and toward this nothing has contributed more in recent years than the development of pump irrigation, as yet in its infancy in the United States, though it has already reclaimed over 3,000,000 acres in British India.

The conditions involved in securing an assured water-supply on the plains are, of course, essentially unlike those which obtain in mountainous regions. Hill countries are generally characterized by copious rainfall, and their varied elevations are likely to afford easy facilities

IRRIGATION PLANT. F. W. RICHTER, GARDEN CITY, KANSAS.

both for impounding and subsequent distribution. The simplest, and usually preferable, system requires only a dam thrown across the ravine or cañon of a stream, so as to form a mountain reservoir, and an open canal or a pipe to convey the stored waters to their intended point of distribution in the adjacent valley or plains. Where such systems have failed to pay the anticipated revenue, it has been in general through ill-chosen location or bad financiering, and not through any inherent defect in the system itself.

With the approach to the plains, however, the conditions are wholly changed. Streams are often intermittent, and dry during the season when water is most needed. Natural locations for reservoirs or favorable sites for dams are infrequent; artificial storage of surface run-off

A TYPICAL PRAIRIE IRRIGATION PLANT. FILLING D. M. FROST'S RESERVOIR, GARDEN CITY, KANSAS.

is generally impracticable, and surface evaporation and loss of stored waters reach their maximum.

Furthermore, it is generally conceded that to dam a stream, say like the Platte or the Arkansas, having a practically bottomless bed of sand and alluvium, and thereby to hold back and divert the flood-waters into service canals or side-hill reservoirs, is impracticable. Numerous canals have been dug along such rivers, with the purpose of diverting a part of their flow during the flood season; but the usual result has been an annual washout of cheaply-constructed head-works and an unreliable and consequently unsatisfactory service to patrons.

HOW SMALL PUMPS MAKE A LARGE STREAM—BY RESERVOIR ACCUMULATION. E. E. FRIZELL, LARNED, KANSAS.

Circumstances must, of course, modify the verdict. Local conditions make a canal not only justifiable, but the best possible system.

Where, too, the plains break into high rolling land, as in eastern Kansas and Nebraska, storage in small reservoirs of perhaps ten to one hundred acres is often practicable and advantageous: but in the flatter valleys and the prairies another solution must be sought, which is found, not in bringing water down from above, but in pumping it up from below.

For beneath a great extent of the prairie, arid and unpromising-looking on its surface, lie vast bodies of subterranean water, filling the spaces of the underlying sands and gravels and moving through them, slowly but constantly, toward the ocean or the valleys of the

GASOLINE CENTRIFUGAL PLANT OF KIPP AND KIMBALL. ONE OF EIGHT ON THE BLUE RIVER, BELOW HASTINGS, NEBRASKA. ENGINE AND BELTING HOUSED. WOODEN SERVICE FLUME TO GARDEN. BLOWING OFF, IN PHOTOGRAPH, FOR EFFECT.

great rivers which flow into it. The underflow in this great gravel basin is maintained by rainfall sinking through the soils above during the months of heaviest precipitation, and perhaps still more by the lateral downward flow, through deep strata, of storm and snow waters from the surrounding, though often distant, hills.

In the utilization of these underground waters lie the largest possibilities for the reclamation and development of our arid lands; and beyond the possibility of fertility there is another and in some aspects a higher boon conferred by pumping irrigation,—that is, the maintenance of individualism and liberty as contrasted with dependence upon a "soulless corporation" which, in exchange for the water furnished,

L. L. DOTY'S CABBAGE PATCH, GARDEN CITY, KANSAS. RESERVOIR AND MILL IN BACKGROUND.

"COMING THROUGH THE RYE." GARDEN CITY, KANSAS.

puts a bond upon the tenants' freedom; the preservation of the "little farm well tilled," with all that it implies of sturdy manhood and self-reliance, in contradistinction to the commercialized and to that extent dehumanized "bonanza" farm enterprises of the west.

It is, however, greatly to be regretted that so many who have undertaken the task have failed to realize that they were confronted by a problem in engineering, rather than in finance or politics. They have undertaken to interpret natural law without proper professional advice, and in natural consequence are fined for contempt in nature's court.

And yet so abundant is her generosity that the percentage of failures

VEGETABLE FARM. D. M. FROST, GARDEN CITY, KANSAS. RESERVOIR, "MOGUL," AND TOWER MILL IN BACKGROUND.

PART OF 500-ACRE ORCHARD. TAKEN FROM TOP OF HOUSE. RESERVOIR AND PUMP-HOUSE IN BACKGROUND. G. M. MUNGER, EUREKA, KANS.

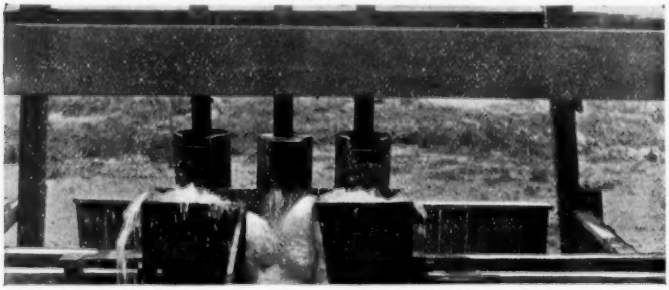
is extremely small. The Kansas State Board of Irrigation reports the number of pumping plants of all kind erected during the past five years as being 18 in 1891, 33 in 1892, 55 in 1893, 224 in 1894, and 1241 in 1895; and of these only six pronounce irrigation by pumping a failure.

Considering the opportunity for mistake or misguidance, such a record is little short of marvellous. It is so easy to put a 2000-gallon-per-minute pump on a 500-gallon-per-minute well, or to assume that with an "average" rainfall of twenty inches, but little additional water will be needed, forgetting that it is not the *average*, but the *minimum* of five inches in the year and only two inches in the first six months against which provision must be made.

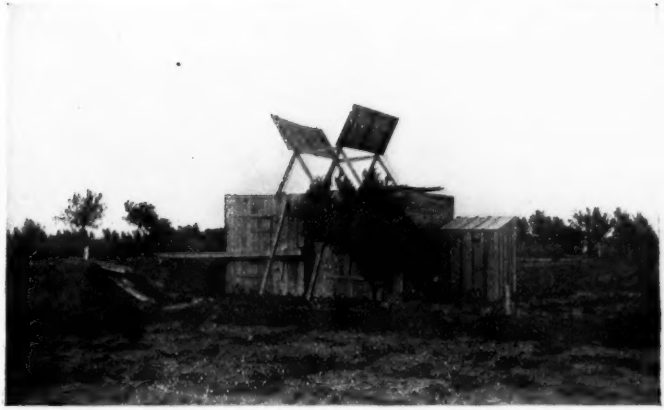
It is so easy to go astray in calculations based on manufacturers' figures of indicated and actual horse power, of friction and water lift; or to base windmill computations on catalogue figures of fifteen miles an hour when the average of the locality is only eleven; or to forget the "law of squares," and the fact that the wind is lightest in the season when the need may be greatest.

And yet, in spite of all these pitfalls, success is being attained in the main; not ideal results perhaps, but very fair financial profit. The mistakes that have been made, the disappointments resulting from less acreage being irrigable by a given plant than the owner had anticipated, have been more than balanced by the phenomenal yields under reliable water-supply and thorough cultivation.

Seventy acres of alfalfa and orchard in Finney county, Kas., yielded, under one man's management, an income of $7,000; a neighbor reports $600 net income from five acres. Half an acre of Edwards county land, planted in onions and cabbage, paid its owner $200, besides "vegetables for family use not measured"; and another Edwards county farmer, who put in a $150 plant "too late, in June when the



THREE 10-IN. CYLINDER PUMPS BEING OPERATED BY ONE 16-FT. AEROMOTOR. PHOTOGRAPH SHOWS FRAME OF FOOT OF TOWER. F. W. RICHTER, GARDEN CITY, KANSAS.



"MOGUL" OR "JUMBO" WINDMILL PUMPING INTO RESERVOIR. GARDEN CITY, KANS.

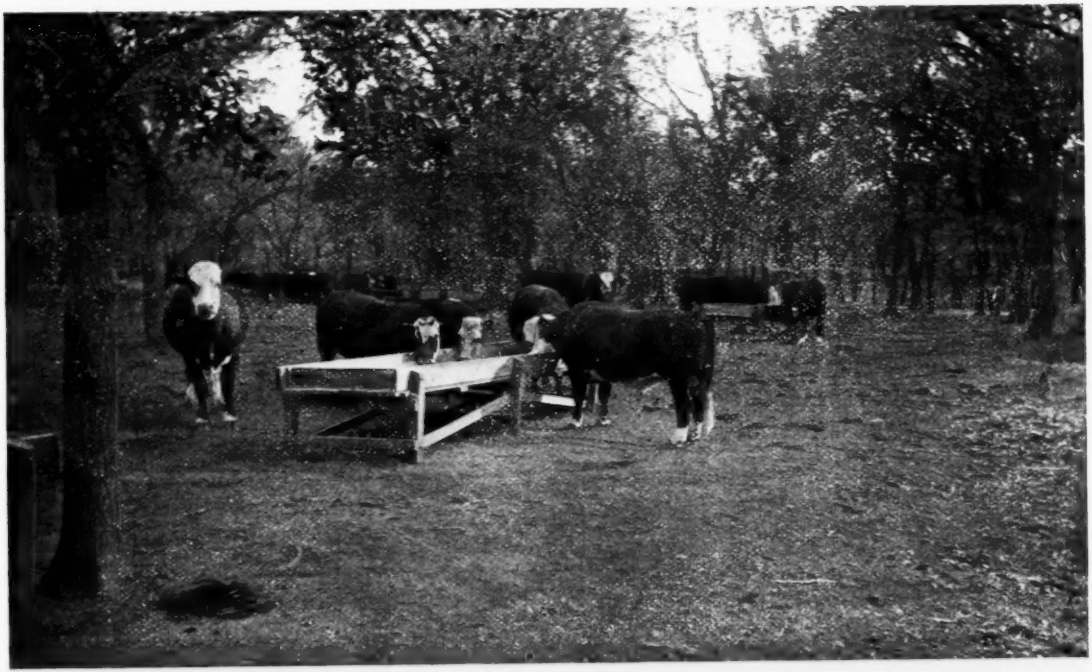
crops had begun to suffer," still obtained from one and one-quarter acres of potatoes and cabbage $400, "besides family supply." An orchard of 16 acres gives gross returns $375 per acre. Eight acres of small fruits yield $626 net per acre. Hundreds of examples might be cited of similar profits under intelligent management.

The selection of the proper plant and power for any given location should be determined by a careful study of the local conditions. By far the most popular pumping-machine on the plains is the wind-mill; that is to say, there are several times as many of these as of all other installations of pumping power combined. From the train at Garden City the traveler may descry seventy to one hundred wind mills, the reason for their great popularity, here as elsewhere, being that "wind is cheap." They are usually of the common radial-fan type, but so varying in detail that any average of their performance can hardly be determined. The brawn and brains of the farmer have even freer play to influence results under irrigation than they had without its aid.

It may perhaps be generally stated that mills from 10 to 16 feet in diameter, mounted on 30-to 40-foot towers, are successfully irrigating from 6 to 20 acres each with a 20-foot lift and from 1 to 3 acres each with a 150-foot lift; and that an investment of $150 to $300 is enabling the farmer to realize returns of $20 to $100 per acre.

Even this investment, with its assured reward, is, however, beyond the reach of many a struggling tiller of the soil who, perhaps, has lost crop after crop through a continually disappointed trust in a more reliable rainfall, until he finds himself forced by necessity to the adoption

SOME OF BARTLETT'S APPLES. GARDEN CITY, KANSAS.

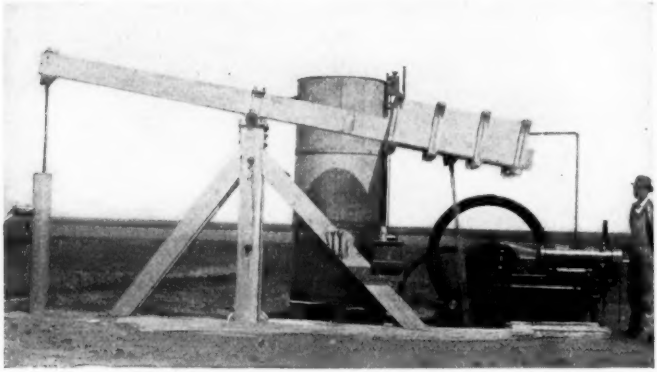


CORN-FINISHING CATTLE FOR MARKET. THE ALFALFA IRRIGATION AND LAND CO.

of irrigation, and yet unable to consult real economy in the purchase of proper machinery.

From some such situation as his arose the device of the "Mogul," a cheap substitute for the tower mill. The Mogul is practically an inverted undershot wheel, the shaft being horizontal and the lower half of the wheel being boxed around to keep off the wind, which thus strikes only the upper sails. It, is of course, set to catch the prevailing winds, which in Kansas are generally north or south, and is arranged to work equally well with either; but it diminishes rapidly in efficiency as the wind hauls toward the east or west, and is also at a disadvantage in that it catches only surface currents, which are always more sluggish than the breezes thirty or forty feet from the ground. Its only merits are cheapness and the possibility of construction by home labor. A Mogul 12 feet in diameter and 14 feet long, with eight fans 2×14, will irrigate from 1 to 2 acres with a 20-foot lift, and, if built new and all labor paid for, will cost from $100 to $200. If constructed (as it often is) by the farmer himself from old material on hand, the cash outlay may be as low as $25.

Contrary to popular opinion, however, cheap wind does not of necessity supply the cheapest power, and economy as well as efficiency may be best served by the substitution of other motive force. This hardly accounts for the occasional use of animal powers, geared to an endless chain carrying buckets, or for the belting of steam threshing engines to centrifugal pumps; such extraordinary devices may be passed over as makeshifts, ingenious and commendable as an exhibition



STATE PUMPING PLANT, GOODLAND, KANSAS.

10 "Actual H. P." Gasoline Engine, operating a 5½ inch cylinder with 36 inch stroke, in a 6-inch well, 170 feet deep, and raising, from the underflow, 6000 gallons per hour.

of determination in the face of obstacles, but destined to give way to something better.

The first place in order of mention among the applications of mechanical as distinguished from natural force may then be given to the gasoline engines, driving various forms of pumps; centrifugal or auger types for short lifts from creeks, ponds, or open wells; rotary pumps (positive) for longer lifts; and reciprocal, cylinder pumping engines for still higher lifts, as at the Goodland State pumping-station. These plants cost, complete, anywhere from $500 to $1,500, perhaps in the average approximating the lower limit more nearly than the higher one.

Above these again rank the compound duplex pumping engines for the higher duties, approaching in cost and capacity small or even medium-sized municipal plants. Such large installations, on account of the magnitude of the capital required for their equipment and

FINNEY COUNTY FAIR. GARDEN CITY, KANSAS.

operation, are naturally few in number, many even of those who could afford the outlay being disposed at present to wait until the results of others' experience have put the matter beyond what they are still inclined to consider an experimental stage; and yet, where they are installed, large plants are for obvious reasons much the more economical proportionately.

Where large power is required, however, the question of the source of energy is a serious one. Gasoline shows a tendency, with the rapid increase in its application, to advance in price; coal sells for $4 to $6 a ton delivered at stations on the plains.

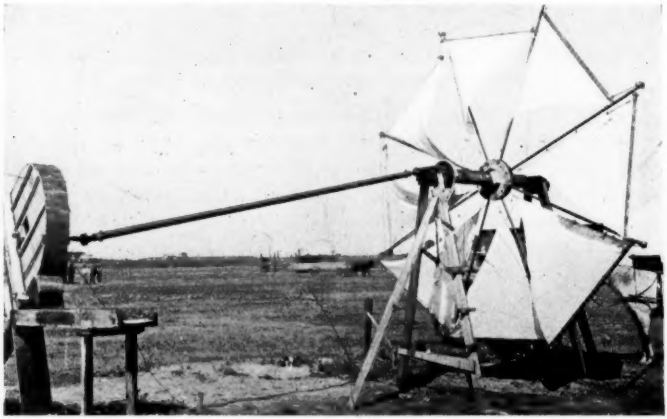
On the other hand, the free air is lightest and least available during the dryest months, when power is most needed. Only, the power of the sun seems to wax and wane in direct ratio to the need of water: who will enter this inviting field for inventive genius, and give us a

STACKING ALFALFA. F. W. RICHTER'S FARM, GARDEN CITY, KANSAS.

practical helio-motor, or other and more probably reliable source of power? He will reap a rich reward for his labor.

For, after all, pump irrigation, like many other things, is serviceable and desirable only if it can be made to pay. Mr. Geo. M. Munger, of Eureka, Greenwood county, Kans., has summed up the matter in a manner well worthy of quotation. Mr. Munger owns a steam pumping plant of 4,000,000 gallons, daily capacity, irrigating 500 acres, and therefore may well rank as an authority.

In a recent communication to the State Board of Horticulture, he says: "The question whether or not it pays is the vital one to be considered. Should a man obtain by irrigation 100 bushels of corn

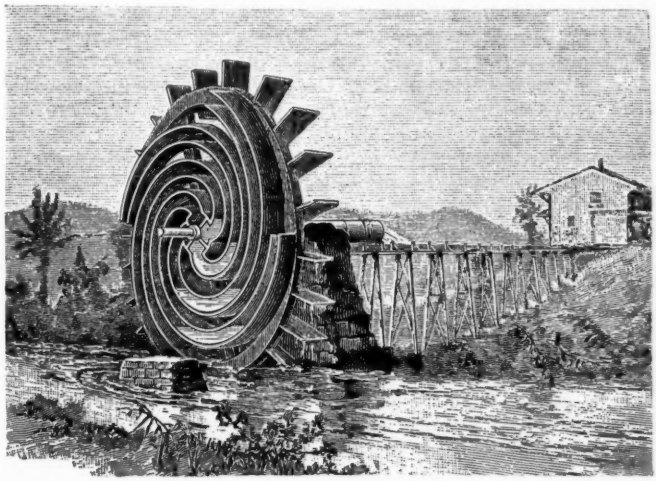


"DEFENDER" WINDMILL. A SAMPLE OF WHAT INVENTIVE GENIUS (?) IS DOING ON THE PLAINS.

per acre and get 15 or 20 cents a bushel for it, he would not be making headway very rapidly; but, if a man has a bearing orchard that is yielding an occasional crop of 50 to 100 bushels per acre, of which one-half to three-fourths must be classed as seconds or culls, and if, by irrigating that orchard, he can increase the crop to three times the quantity and have it all grade 'fancy,' it is easy to see that at any prices for fruits that have been known to prevail he could afford to spend a very considerable sum per acre to install an irrigation plant.

"Then if, in place of an occasional crop, the irrigation will give him regular annual crops of this class, it requires no bookkeeping to discover that it is profitable."

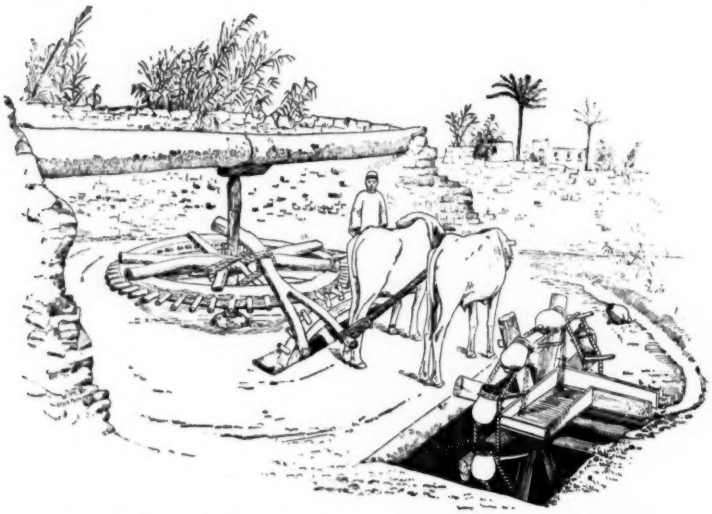
Crop.	Annual Returns.	Dollars Per Acre.	
	Average Bottom Land Not Irrigated.	Average Irrigated.	Best Results (Average) Irrigated.
Alfalfa hay and seed	$21	$36	$61
Alfalfa, hay only	14	23	36
Corn	5	11	24
Wheat	7	18	29
Potatoes	25	137	250
Sweet Potatoes	25	172	333
Onions	50	275	550
Small fruits	100	625	1100
Orchard	50	537	1000



EGYPTIAN "TYMPANUM."

What is actually being accomplished in average practice is exhibited in the foregoing tables, compiled from returns reported to the writer by a large number of intelligent irrigators on the western Kansas plains.

Even allowing for exaggeration or over-enthusiasm, the reported results would certainly seem to justify the erection of pumping-plants wherever water is found at the depth at which it ordinarily occurs in abundance. But let it not be supposed for a moment that irrigation eliminates from the farmer's work the elements of painstaking care and good judgment: on the contrary, it affords a larger field for their employment, and even demands their exercise in the highest degree,



A PERSIAN WATER WHEEL. ESTIMATED CAPACITY, 2000 CUBIC FEET PER DAY.

that the best results may be secured from the land under the improved conditions and the highest returns may be obtained from the additional investment.

The man who raises but one crop is wasting his opportunities; he who manages, on the other hand, to gather two harvests from the same ground, say by following early potatoes with late cabbage, is getting double value for his irrigation. On favorable soils also much can be done, by deep plowing and winter irrigation, to store up water in the subsoil; and a given pumping-plant may thus be made adequate to twice the acreage it could protect if it were called upon to furnish all

the moisture necessary to preserve the crops through the dry season.

It is not conceivable that irrigation, even by pumping, can ever be made universally applicable. There ridges and high plains to which it would not be profitable, even if practicable, to carry a water-supply ; and these, in the region under discussion, must be reserved for alfalfa, some advantage which, though greatly improved by irrigation, can be grown to some advantage without. There will still be vast areas where no water-supply can be secured ; it may be that the total reclaimable acreage in the plains country will not exceed 15 per cent., or at most 30 per cent., of the entire area, very irregularly distributed, the possibility of irrigation ex tending perhaps to the entirety of some valleys and being wholly denied to adjacent ridges.

Within the irrigable area, however, the possibilities are almost boundless. The densest populations the world has known have been sustained upon an agriculture dependent upon irrigation. The semi-arid regions of Kansas and Nebraska, once filled with the promise and even the presence of prosperous cities, have suffered destitution and depopulation through the neglect of irrigation ; under the new order of things they are again stirring with life.

Abandoned homesteads are being taken up anew ; land companies, having developed a water-supply and secured large tracts of land from non-residents, usually in exchange for capital stock, are putting the hills into cattle ranges and the valleys into orchards and vegetable farms, into sugar beets and alfalfa, for development and tillage by new-comers, and the aforetime desolation is already fragrant with verdure andbudding with fertility.

Millions of acres of valley lands, now held at five to twelve dollars an acre, having under them the most reliable of all inland water-supplies, can be equipped with pumping-plants at a cost of five to ten dollars an acre, and irrigated at an annual expense of one to five dollars per acre ; and the resultant income can be made equal to ten per cent. on a valuation of one hundred dollars per acre, and often several times more. I am convinced beyond question that lands in the Arkansas valley, or any other valley having as reliable an underflow, are among the best investments in the country at present.

The day of the dry-farming lottery is passing ; crops are no longer to be scratched in upon unbroken lands by the square mile, but are being planted, subsoiled, and watered, and are yielding surely and abundantly. A maximum crop every year is far better than an occasional crop in the years when the rainfall is seasonable. Irrigation is the only insurance that provides against drouths, hot winds, and frosts, and repays annually to the policy-holder the full face of the policy ; and pump irrigation on the plains is the best and surest of all.

THE FUTURE OF ELEVATED RAILROADS.

By Eugene Klapp.

IT is questionable if any more elevated railroads will be built in the United States. The roads in New York have, of course, been a gold mine, and all others have been the outcome of attempts to duplicate the successes of those in New York without thoroughly weighing the conditions there existing. New York, a long, narrow strip of land which in parts is the most densely populated locality in the world, is served by four parallel lines of elevated roads, so arranged that there is hardly one of the entire population who is not within access of one or the other of them.

Very different is the case in Brooklyn and Chicago, where the population is much more scattered, and where the roads each represent but one spoke of a gigantic wheel; the further one goes from the center or hub, the greater the distances on either side which are inaccessible. The Brooklyn roads have been for a long time a great disappointment financially, while two of those in Chicago have already gone down beneath their burden of "fixed charges." It is true that in Chicago neither of the roads had adequate terminal facilities or approached near enough to the heart of the business district to successfully compete with the very excellent cable competition on the surface. This difficulty, already partially overcome on the Lake Street Road, will soon be completely effaced for all the Chicago roads by the completion of the "Union Loop," upon which all four elevated roads will have equal rights, and which will make them one of the most complete transportation systems of the world.

In Chicago a new element of trouble has been introduced by the purchase of a "right of way." This plan was first introduced by the "Alley L," so-called, and was in a great measure adopted because, by so doing, the road was enabled to get an ordinance through the city council, thus outstripping a rival which was asking for a franchise upon a public street only half a block away. The plan has since been continued by the Metropolitan and the Northwestern (under construction) on the ground that all damages to abutting property are thus settled in advance, and the road made comparatively free from the vexatious and very costly litigation to which the eastern roads are constantly subjected. On the other hand, it has increased the first cost and consequently the yearly interest account to an enormous extent, so that it certainly is questionable whether it is better to saddle a young and struggling road with such charges, or to defer them for five or six

years, at which time the road, having built up its territory, would be better able to meet the expense.

Moreover, on the plan upon which most railroads are at present financed, this first cost for right of way must be met with money obtained from bonds placed at a ruinous discount and carrying with them a stock bonus almost sufficient in itself to pay the damages that may be adjudged in after years. Again, the Illinois law requires the petition of a majority of the "frontage on each mile of street sought to be used" before the council can act; hence a road constructed in a street under such circumstances has at least one half of the frontage estopped from any action for damages. For, though the case, so far as I know, has never been passed upon by any court, it does not seem in the bounds of common sense that a man can petition the council for a certain thing and then turn around and sue for damages, upon having his petition granted. Despite these drawbacks, however, there can be no question that, with the excellent terminal facilities afforded by the loop, and with the completion of a few short and very much needed branches into thickly-settled suburbs, all the Chicago roads will be on a secure and paying basis. The natural increase in population and the building up of their territories by reason of the unexcelled service the roads can give will in a few years unquestionably make them very valuable properties. It is clear that, if Chicago, whose population has increased beyond all comparison, can not without less difficulty support roads of the present character, then certainly no other city in the union can hold out any inducement for capital to originate such enterprises.

Yet there is many a city of moderate size where the business district is much congested and traffic and life endangered by the cable and electric lines, and where a few miles of elevated structure would greatly benefit all concerned.

These reflections have led to a thorough investigation of methods of cheapening the construction of elevated railroads, with a view to adapting them more generally to the use of smaller cities and at the same time to making them a financial possibility.

What is the origin of the present elevated railroad, and what has forced it into its present form of structure and equipment? When the first New York road was built in 1869 or thereabouts, there were but two forms of power,—steam and horse. True, the owners of this pioneer road experimented with a crude chain, using it somewhat in the manner of the modern cable, but so unsuccessfully as to cause its abandonment in a very short time. Horses being obviously out of the question, there remained only steam, which was consequently adopted as the motive power by necessity.

A steam motor requires two men to operate it; hence it is very

much cheaper to run one train of four cars than two trains of two cars. To this consideration more than to any other one cause is due the present style of elevated railroad.

To operate such trains there is required a heavy motor with tractive force sufficient to haul four or five cars, which again necessitates a heavy and massive supporting structure.

In this way, then, and by reason of the phenomenal traffic which the New York roads soon secured, the present comparatively heavy train was developed, and has been copied by all the succeeding roads.

Some of the natural sequences of this method of equipment, however, are as follows: When the traffic is not heavy, not only are the cars cut off, but the interval is necessarily made longer, in order to make the saving which, as before indicated, is possible by using the larger and fewer units instead of the smaller and more numerous. Yet it is a well-recognized principle of successful street-railway management that small and frequent units not only take what business there may be, but seem almost to create it.

The result is that, instead of having an elevated street-railway, which is what most cities require, we have an elevated "trunk line," with trains of from three to five cars running during the less busy portions of the day at intervals of from five to seven, or even ten, minutes, involving a heavy, costly, and objectionable structure. When a man wants to ride a couple of miles, more or less, in a city, he does not wish to wait eight minutes for his conveyance while perhaps he sees four or five surface street cars going by during the same interval.

A comparison in train-crew wages by both methods of operation is shown in the following table, assuming both to be operated by electricity with but one man on the motor.

Cost of labor per 4-car train every six minutes:

HEAVY CARS.

1 Motor man,	$2.50 per day.	$8.10 per day.
1 Conductor,	2.00 " "	
2 Guards,	3.60 " "	

Seating capacity, 188. Weight of train, 87 tons.

Cost of labor per day for *three* 2-car trains at intervals of 2 minutes:

LIGHT CARS.

3 Motor men,	$6.75 per day.	$12.15 per day.
3 Conductors,	5.40 " "	

Seating capacity, 180. Weight of 3 trains, 48 tons.

Thus the cost of labor compels managers who have heavy cars to bunch them into large units. For the same carrying capacity the labor

bills are as $8.10 is to $12.15. But against this the manager with light cars can place his smaller tonnage,—48 instead of 87.

Now, as it takes just as much coal to haul a ton of dead weight as a ton of passengers, it is clear that the saving in fuel and power-house equipment will be almost one-half. An elevated car weighs about 15 tons empty, and seats only 48 passengers. A surface street car weighing 4 tons will seat 26. In one case, 15 tons of dead weight to only 3 tons of live load; in the other, 4 tons of dead to 2 of live. Even if the above consideration in itself does not counterbalance the extra labor bill, which in many cases it will, there is always the saving in interest on the cost of the cheaper and lighter structure, besides the increased earnings due to better service.

The average speed may be raised on the lighter road, because its motors can be made to run just as fast for a maximum, while its stops and starts can be made much faster.

A comparison of the cost of construction per mile of road is shown in the following table. The gross figures for the heavy road are from the actual expenditures of two of the present elevated roads; the figures for the lighter road, given in detail, have been estimated with great care, and can be easily substantiated. The heavy roads were built mostly on a purchased right of way, while the lighter road is figured on the basis of the use of the public streets. The total actual cost per mile of a standard elevated road varies from $850,000 to $1,235,000, depending on the condition of the iron, labor, and money market, at the time of construction.

TABLE OF ESTIMATED COST OF LIGHT ELEVATED ROAD.

	One mile.		One mile.
Engineering	$ 5,555	Clerks	$ 1,111
Iron structure	52,000	Stationery and printing	200
Foundations	17,600	Contingencies	32,549
Track	22,222	Legal expenses	2,000
Stations	24,000	Taxes	555
Shops	2,777	Elevated yard	8,888
Tools and machinery	777	Power-house	16,660
Telegraph	111	Line	11,110
Motors	22,222	Bond expenses	1,666
Cars	22,222	Discount on bonds	25,210
Real estate for power-house and yards	13,333	Interest on bonds during construction	14,328
Office expenses	1,555		
		Total cost of one mile	$298,651

In the above estimate it is assumed that stations will be much closer together than is possible on ordinary elevated roads. At the same time they can be made very much less expensive to build, maintain, and operate. If there were five stations per mile, instead of only two, as

is now usual, there would be a great gain of traffic from intermediate points.

The interest charges upon the above road would be five per cent. on $298,657.00, or $14,932.85 per mile of road against at least $42,500.00 per mile of standard road! The following table of operating expenses per day shows the cost, in each case, of carrying the same number of people. The figures are compiled from the actual expenses of one of the standard roads during one year, and are altered only by the substitution of estimates for such items as would be affected by the substitution of electricity as a motive power, and by a reduction in station expenses made possible by the plan of operation adopted by the newest roads. The former are estimated on data from the practice of two or three large surface electric systems furnished to the writer. The endeavor has been to pick out from the practice of several standard roads all those points which seem to be best and most economical, in order to make the comparison as fair as possible.

TABLE OF OPERATING EXPENSES PER DAY.

Item.	Standard Road.	Light Road.	Saving.
General expenses including taxes, damages, legal expenses, etc.	164	164	
Maintenance of way	75	60	15
Maintenance of rolling stock	77	77	
Motormen	133	172	—39
Powerhouse force	56	56	
Hostlers, wipers, etc.	10	10	
Fuel	306	125	181
Water	23	10	13
Oil, waste, and tallow	4	4	
Conductors and guards	218	158	60
Yardmen, switchmen, and couplers	45	20	25
Inspectors and cleaners	28	28	
Ticket sellers	98	150	—52
Porters and laborers	28	20	8
Station supplies	19	9	10
Telegraph	21	21	
Interest on bonds	1,048*	371	677
Totals	$2,353	$1,455	$898

*Note—Interest figured at 5% on least cost of standard road, as figured above.

In the above table, where figures are estimated for the lighter road, they have purposely been made high in comparison with those for the other road, in order to be on the safe side. It will be seen, upon analyzing this estimate, that, of the total saving of $898 per day, only $221 is effected in operating expenses, the balance, $677, being due to saving in interest charges.

These figures are intended to cover all regular expenditures of any nature whatsoever, year in and year out, so that whatever difference

there may be between the expense, $1,455 per day, and the income may be considered applicable upon the stock as a dividend. The cost of building the above hypothetical road at about $300,000 per mile would be $2,700,000. It is one of the claims herein put forth that a road constructed and operated upon the plan proposed would be better able to compete with adjacent surface roads and would carry more passengers, hence earning a greater revenue. But, assuming that the traffic were only the same as that of the standard road with which all the above comparisons have been made, the net earnings would be sufficient to pay a dividend of over seven per cent. upon the capital stock, providing the issue of stock was equal to the gross cost of the proposed road.

Conservative management might reserve three to four per cent. for extraordinary expenses. The structure would need repainting throughout once in every four to five years. The ties would probably last ten years, and the rails possibly fifteen, but some day the need of renewal would become pressing, and the money would have to be provided in some way.

Allowing, then, for this reserve fund, there is still left a fair interest for the stock, with the prospect of getting whatever increase in earnings the road might show, when provided with proper terminals and branches. Now, as before stated, the standard road will eventually do as well as this, and some day even better; but it is far from doing so to-day, and can only gradually arrive at the point where a light road would have been already.

It may be objected that such a road cannot have the ultimate capacity of the larger and heavier road. This is by no means certain, as the cars or trains, being so light and easily stopped, can be safely run much closer together. The number of people carried each day on some of our various cable and trolley roads is enormous,—so large, in fact, that, should the capacity of the road ever be reached, it would have already fulfilled its mission as a gold mine, and its owners could well afford to double up the tracks, or build a parallel road on an adjacent street.

The future, therefore, of elevated roads cannot lie in the beaten track of the present practice; but there are few cities of the second or third rank that cannot aspire to supporting one or more elevated roads planned and constructed somewhat on the lines suggested. Only in this way can the safety and convenience of their streets be assured.

THE RELATIVE VALUE OF DIFFERENT COALS.

By H. M. Chance.

WHEN used to produce heat, the value of coal depends upon the quantity of heat obtained from it. This is the chief function it performs, and the one this article proposes to discuss. Its use as a metallurgical agent for reducing or smelting metals from their ores, and for the working and manipulation of metals, constitutes a distinct field subject to conditions which cannot be here defined.

From one pound of good coal enough heat can be obtained to evaporate a little more than a gallon, say five quarts or ten pounds, of water. If, with such a coal, another be compared which will evaporate but two and one-half quarts, or five pounds, of water, the thermal value of the second coal is said to be one-half that of the first.

The relative thermal values of coals are, therefore, their relative capacities for producing heat, and it is evident that commercial values should be proportional to these thermal values.

In determining thermal values, the scientist or physicist deals, or attempts to deal, with the whole amount of heat produced by the complete combustion of a given quantity of fuel, including the heat escaping with the waste gases through the chimney, that lost by radiation and even that carried away in removing the hot ashes.*

As in practice much of this heat is necessarily lost through radiation and imperfect combustion, some carbon going off as smoke or soot and some combustible gases escaping unconsumed, we cannot adopt the scientist's standard for practical work. Hence we take as a measure of value the actual heat utilized, as shown by the quantity of water evaporated by each pound of coal under the conditions present at any particular steaming plant, the thermal values so determined indicating the real value to the consumer of the coals under consideration.

When fuel-cost forms a large item in the total cost of production, the value of coals is often the subject of careful experimentation.

* The thermal unit used in this country and Great Britain is the quantity of heat necessary to raise one pound of water one degree Fahrenheit. The French thermal unit, in general use by scientists of all countries, is the quantity of heat necessary to raise one gram of water one degree Centigrade. The thermal unit commonly used in comparing the value of coals is the number of gallons of water evaporated by one pound of coal.

Practical trial runs are made with different coals to determine under existing conditions which coal gives the best results at the lowest relative cost. The results of such tests often develop the fact that personal judgment in such matters, unless based upon actual figures, is of little value. I have in mind a simple little case of this kind, where the choice of fuels was between two pea (anthracite) coals, one of which was better, but also higher-priced, than the other. The judgment of the fireman and engineer was that it did not pay to buy the cheaper fuel, that the plant took "one-third more coal" when using it, etc.; the actual figures for equal work were:

100 tons Pea coal.....@ 3.50.....$350
108 " " " .....@ 3.00.....$324

When careful records are kept of the coal consumed and the water evaporated or work turned out, the relative values of any coals can be reliably determined by trial, but such tests are expensive and troublesome, involving the cleaning-up of all coal remaining on hand, with perhaps more or less trouble in making steam with the new fuel until the firemen learn its peculiarities. Hence the consumer is generally averse to experimentation or change, and, unless fully convinced that the new article is much better or much cheaper than the old, cannot be persuaded to try it.

A change in fuel is especially obnoxious to most firemen. Protests from both firemen and engineers may be expected, whenever the fuel is changed, whether the change be from a poor to a good fuel, or *vice versa*. They arise from the fact that the thermal value of a fuel at any plant—*i. e.*, the water converted into steam—depends largely upon the conditions present at that plant, and also upon the method of firing and the knowledge, versatility, and integrity of the firemen using it.

An instance illustrating this feature occurred in the experience of the writer, who was consulted regarding the fuel-supply for a steaming plant consisting of about a dozen isolated boiler plants consuming in the aggregate about one hundred tons of coal per day. The fuel in use was a good coal, but, as it contained much gas, was "sooty" and fouled the boiler tubes, notwithstanding frequent scraping and blowing out. Consequently the fires were being forced nearly all the time, and the economy of the plants as steam producers was correspondingly low. As a result of the conference, the writer was authorized to contract for a supply of fuel better adapted to the requirements of the plants, and at once secured a quantity of one of the best bituminous coals coming into the Atlantic seaboard market,—a fuel famous upon the transatlantic liners. This fuel contained less gas and deposited little soot in the tubes. Nevertheless, upon the arrival of that coal, trouble arose at every plant; protests came in from almost every engineer and

fireman. They stated that they simply could not make steam; that the coal was miserable stuff, "contained no gas," "made no flame," etc. At one plant, where a delayed shipment of the former coal was received after the delivery of the new coal had commenced at the other plants, the firemen sent in the same protest,—they "could not possibly make steam with the new (?) fuel"! In about a week the complaints practically ceased, and more steam was made at all the plants with less fuel than before the change.

The writer also recalls a similar experience with the firemen of a railway where a change in fuel was met by protests from all parts of the system, which, however, quickly subsided when the men had learned how to handle the new fuel and realized that it was better than that formerly used.

As the thermal value of a fuel, as determined under the ideal conditions required for scientific test, is never realized or even approximated in practice, the consumer is interested only in the relative thermal values as developed under average conditions at his own plant. And the conditions at different steaming plants vary so widely that the best and cheapest fuel for one plant may be a very unsatisfactory and costly fuel at another. Some of the best coals produce light, fine, even pulverulent ash, which, as burned under some boilers with horizontal tubes, quickly clogs up the tubes and greatly reduces the economy and capacity of the plant; under such conditions an inferior coal may produce better results, while, in a plant with vertical tubes or in a highly-inclined water-tube boiler, the results would be very different. The same conditions affect the thermal values of coals with large percentages of gas, and of coals yielding a very rich or smoky gas. Here it becomes a question of grate area, thickness of fire, size and arrangement of combustion chamber, and admission of air above the grate. If these conditions are not adapted to the coal, no possible amount of scraping and blowing-out of the tubes will keep them clean enough to give satisfactory results with such a fuel, and better results may be attained with a much poorer coal of different character.

It may, however, be asserted at the outset that conditions causing in practice such abnormal relative thermal values should be regarded with suspicion, and it is safe to predict that, where such conditions obtain, it is entirely possible, in a majority of cases, to so correct the management, construction, or arrangement of the plant as to make it produce results consistent with the real values of the fuels used. At the same time we should remember that what may prove a faulty and wasteful design for burning one kind of coal may be capable of developing the highest efficiency from another variety.

The problem usually presented is to determine not what grate and

boiler setting will develop the best results from the best fuel at the lowest relative cost, but, given a particular boiler with fixed grate and boiler setting, which of several available coals will give the best results at the lowest relative cost. The coal answering these conditions is the best fuel for that particular plant.

As it is manifestly impossible for each consumer to experiment with all of the numerous grades and varieties of coal in the market, a quick and ready method is needed for determining what grades will justify trial. If he is an expert judge of coal, much can be learned from an inspection of the coal, and many grades may be rejected at sight because of the visibly large quantity of slate or sulphur present. If he is not an expert judge of coal, the consumer may profitably be guided by the established reputation, or lack of reputation, of any coal. But the composition of the coal, as shown by chemical analyses, is the best criterion, care being taken always that the analyses represent properly-selected average samples.

In analyzing coal, the chemist first drives off the water by evaporation, by heating the coal to 212° or 225° F., the loss of weight giving the percentage of water. The coal is then heated to a red heat in a covered crucible, thus driving off the gas, which is the volatile combustible hydrocarbon, usually called by the chemist "volatile matter," the loss of weight giving the percentage of this constituent. The sample is next heated to a bright red heat in an uncovered crucible, the admission of air to which permits the carbon (coke) to burn, leaving only the ash behind, the loss of weight showing the percentage of carbon,—called "fixed carbon" by the chemist,—and the residue the percentage of ash. A separate analysis is necessary to determine the percentage of sulphur, which is deducted from the percentages of volatile matter and fixed carbon, already determined, as a part of the sulphur escapes with the volatile matter and the remainder burns off with the carbon.

The valuable constituents of coal are its carbon and hydrocarbon (volatile matter) contents; the waste matter consists of water, ash, and sulphur.

Other things being equal, coals with high percentages of volatile matter have greater ultimate thermal values than coals with small percentages of volatile matter. The relative thermal values of the carbon of coal and of the volatile matter are about as eight is to fourteen. Assuming for comparison two coals, one with 75 per cent. of carbon and 20 per cent. of volatile matter, and the other with 55 per cent. of carbon and 40 per cent. of volatile matter, the theoretical thermal values are in the ratio of about 8.80 to 10; but such differences are not obtainable in ordinary tests, much less in actual work,

owing to the large loss of heat due to unconsumed gases, to imperfect combustion (always experienced in using coals with a high percentage of volatile matter), and to the difficulty of effecting anything like complete combustion of the gases, some of the hydrocarbons being burned only to carbonic oxid (CO) instead of to carbonic acid (CO_2), with a development of less than one-half the heat which would be produced by complete combustion.

Hence, while the law remains that the thermal value of a coal rises with the percentage of hydrocarbons (volatile matter), it will not do to apply this law to present practice. In fact, the bituminous coals, from which some of the best steaming results are obtained, are those coming into the Atlantic seaport markets, which carry a comparatively low percentage of volatile matter,—say, from eighteen to thirty per cent.

The more perfect combustion and cleaner boiler tubes which can be maintained when burning anthracite enable the consumer to realize a high thermal value from it, notwithstanding the small percentage of volatile matter which anthracite coals contain.

By adding together the percentages of volatile matter and fixed carbon, we obtain the percentage of combustible matter contained by any coal. Coals with high percentages of combustible matter generally have higher fuel values than coals with low percentages of combustibles. Prices should not vary widely from the relative quantities of combustible matter.

A coal with 90 per cent. of combustibles means a coal with 1,800 pounds of combustible matter and 200 pounds of waste matter in each ton; a coal with 80 per cent. of combustibles has 1,600 pounds of fuel and 400 pounds of waste matter in each ton.

Few coals contain more than 90 or 92 per cent. of combustible matter. The combustible matter in high-grade coals may be taken as ranging from 88 up to 95 per cent.

The accompanying table shows the typical composition of high- and low grade anthracite, semi-bituminous, and bituminous coals.

HIGH-GRADE COALS.

	Anthracite.	Semi-bituminous.	Bituminous.
Water	1.00	1.00	1.00
Volatile Matter	5.00	18.00	40.00
Fixed Carbon	88.50	75.50	53.50
Sulphur	.50	.50	.50
Ash	5.00	5.00	5.00
	100.00	100.00	100.00

LOW-GRADE COALS.

	Anthracite.	Semi-bituminous.	Bituminous.
Water	2.00	3.00	4.00
Volatile Matter	5.00	15.00	34.00
Fixed Carbon	75.00	67.00	46.50
Sulphur	2.00	3.00	3.50
Ash	16.00	12.00	12.00
	100.00	100.00	100.00

When the relative values determined by actual use vary widely from the values indicated by the percentages of combustible matter, it is advisable to examine closely into the arrangement, condition, and management of the plant; for it is evident that the plant is wasting more heat with some coals than with others, and the cause of this may be remediable, and its recognition and rectification will probably lead to higher efficiency with all coals.

While the consumer may, therefore, rely upon the results of analyses in determining whether, at the price asked for it, any coal will justify its experimental use for the purpose of testing its true value to him, depending principally upon the percentages of total combustibles as shown by the analyses, the character of the impurities is also a factor of much importance.

Each one per cent. of water shown by the analysis means twenty pounds of water to the ton, and a coal showing five per cent. of water will, therefore, contain one hundred pounds of water to the ton. Before the coal can burn, this water must be evaporated by the heat of the fire, thus causing a waste of heat that would otherwise be available. To evaporate one hundred pounds of water will require the heat generated by the combustion of ten or fifteen pounds of coal. Hence the presence of one hundred pounds of water is equivalent to a reduction in the combustibles in each ton of one hundred and ten or one hundred and fifteen pounds.

The low thermal value of many western coals, and especially of the western lignites and lignitic coals, is principally due to large percentages of water,—the range being from about five per cent. up to twenty-four per cent. of water.

Large ash percentages are objectionable, not only because they reduce the quantity of combustibles per ton, but because of the increased cost of labor in firing and in removing and disposing of the ashes, and also because of losses occasioned by the frequent cleaning of fires necessitated by high ash coals.

The character of the ash is also of considerable importance. If easily fusible, it quickly closes the interstices of the grate, burning the grate-bars and necessitating frequent cleaning of the fires, with

inevitable waste of fuel and chilling of the boilers. If the ash contains large pieces of slate, frequent cleaning, with much loss of coal, can be predicted. Coal yielding a fine pulverulent ash is unsatisfactory under conditions already described.

Because of the damage sometimes done to grates, boilers, settings, and stacks by coal containing a large percentage of sulphur, this impurity is very generally regarded as the most objectionable constituent of coal.

Few coals contain less than one per cent. of sulphur; in many the sulphur rises to two or three per cent.; while some coals much used in the west contain as high as four per cent., or more, of sulphur.

When injury from sulphur is detected, inquiry is generally instituted at once to determine how much sulphur the coal in use contains. If it be found that the coal contains only a small sulphur percentage, the damage is regarded as unavoidable, perhaps no complaint is made, and the fact and cause of damage never gain publicity. Should, however, the coal used be found high in sulphur, the damage is at once attributed to this cause; the miner or agent is censured for shipping inferior fuel, perhaps not up to contract stipulation; that concern loses a customer; and the circumstances and supposed cause of the difficulty become more or less generally known to all those directly and indirectly interested. In this way the sale of many coals has been ruined, perhaps justly, possibly unjustly.

As with many other objectionable things, the injurious effects of sulphur are dependent not so much upon its quantity as upon the form in which it exists in coal, and the manner in which the coal is used, and possibly upon the nature of the structural materials with which it is brought into contact.

Coal containing large quantities of sulphur in the form of iron pyrites is unquestionably hard on grate-bars. On the other hand, high sulphur coals are used in some districts with merely nominal damage from this cause. The subject is one not thoroughly understood, and must have careful investigation before it will be safe to make any very positive assertions regarding the action of sulphur in coal.

Meanwhile, in the light of present and past experience, it will be safe to give those coals the preference that show only moderate percentages of this impurity, for it is without doubt the most objectionable element contained in coal.

THE PRESENT STATUS OF AERIAL NAVIGATION.*

By Octave Chanute.

WHEN the writer about four years ago published an article in this magazine on "Progress in Aerial Navigation," † attempting to review the state of the art, and reaching the conclusion that it was now reasonably prudent to experiment, consideration of the subject was just emerging from public incredulity, and there seemed to be but little assurance of any more rapid progress in performance than during the preceding fifty years.

But there seem to be periods of increased activity in the development of particular problems, when they attract the simultaneous attention of competent men, and when knowledge advances by leaps. This has occurred with regard to aerial navigation since 1891, and, while commercial success cannot yet be said to be in sight, there are good reasons for believing that such progress has been made as to warrant hope that men will eventually fly through the air. It is proposed here to state briefly what has been recently accomplished.

It is known that the best achievement thus far made public concerning navigable balloons is that of Messrs. Renaud and Krebs of the French war department, who obtained in 1885 speeds of fourteen miles per hour with the war balloon "La France." This was insufficient to stem most of the winds that blow, but the French aeronautical establishment has since been spending large sums,—$80,000 some years,—partly to determine the best forms to give to such vessels in order to evade air resistance, and the best shape for propelling screws, and partly in experiments upon light motors; so that it was given out in 1893–4 that the French had constructed a new war balloon, the "General Meusnier," which was expected to develop a speed of twenty-five miles an hour, and carry fuel and other supplies for a ten-hour trip. It was to have been tested in the summer of 1895; but, if any such trials were made, they must have been carried on at night, as no public information has been given out, probably to avoid disclosing the secret of such a war engine. An international com-

*We are indebted to Mr. James Means, editor of *The Aeronautical Annual* for 1896, for the very excellent illustrations which accompany this article. The volume edited by Mr. Means will be found both interesting and valuable to everyone concerned with the subject of aeronautics. It is published by Messrs. W. B. Clarke & Co., Boston, Mass., and its price is $1.00.—THE EDITOR.

† THE ENGINEERING MAGAZINE, October, 1891.

petitive trial of navigable balloons is, however, set down as a feature of the French Exposition of 1900, with strict regulations to prevent photographing.

There is little doubt among experts that the speed announced will be realized, but meanwhile other European governments have taken up the research, and England, Germany, Russia, Italy, Portugal, and perhaps other countries, have established aeronautical departments, which are experimenting with both captive and war balloons, so that the next European war will probably make it known that the problem of military balloon propulsion has been approximately solved. This will almost certainly be the case if France and Germany are engaged against each other, the latter nation having, it is said, recently made great advance in the art inaugurated by its rival.

Even in the United States, the subject has attracted legislative attention. A bill was introduced in the senate in 1893 by Mr. Cockrell, offering a reward of $100,000 to any inventor, from whatever part of the world, who should, by January 1, 1900, construct a vessel which should demonstrate the practicability of safely navigating the air at a speed of not less than thirty miles an hour, and capable of carrying passengers and freight weighing at least five tons.

This was reported upon in 1895 by Mr. Brice, from the committee on interstate commerce, indicating that the reward would probably be earned, perhaps by more than one inventor, but that, in consequence of the then condition of the treasury, it was not advisable to pass the bill. It is said to have been reintroduced in the present congress by Senator Lodge.

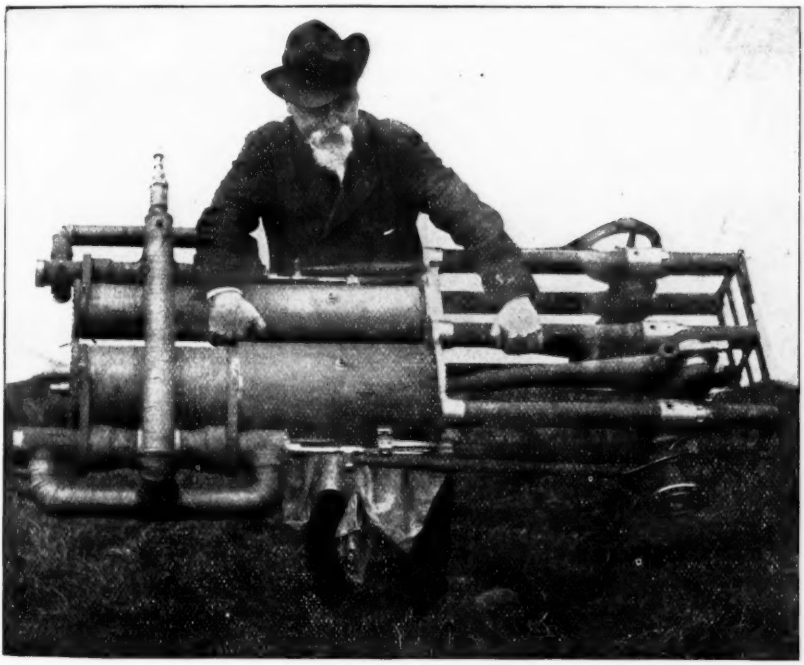
It is, however, now pretty well understood that navigable balloons are so frail, carry so small cargoes, and attain so low speeds, that they are not likely to compete commercially with other means of transportation; but they doubtless will prove useful in war and in exploration, and the mere fact that a committee of the senate has reported on the bill above mentioned marks the advance recently made toward a solution of the problem.

In view of the recognized limitations of the navigable balloon, increased attention has been given of late to flying machines proper, which are sustained, like birds, by impact upon the air, and which promise speeds varying from sixty to one hundred and fifty miles an hour. In this direction great advances have been accomplished during the past four years, and men of the highest scientific and mechanical ability have given their thought, time, and money to experiment.

And first must be mentioned Professor Langley of the Smithsonian Institution, who published in 1891 his "Experiments in Aerodynamics," in which he gave the results of his experiments with planes,

confirmed the empirical formula of Duchemin concerning air resistances, and enunciated the law that, within certain limits, high speeds through the air will be more economical of power than low speeds.

These labors gave data to searchers in this department of physics, and made it evident that aviation is not a utopian idea. It is said that farther experiments by Professor Langley have confirmed his opinion, then expressed, that better results can be obtained with curved surfaces



MR. MAXIM HOLDING ONE OF HIS ENGINES FOR THE PHOTOGRAPHER.

than with planes, and it is to be hoped that he will also be able to show how equilibrium is to be obtained in the air.

About the same time (1890) Mr. H. S. Maxim, the celebrated inventor, carried on for himself and quite independently experiments in air reactions analogous to those of Professor Langley, and he came to practically the same conclusions concerning them. He then designed, built, and developed a steam engine of extraordinary lightness

in proportion to its energy, so that he demonstrated in 1894 that he had an engine of three hundred and sixty-two horse power, weighing, with its boiler, condenser, and adjuncts, less than eleven pounds to the horse power,—say one-twentieth as much proportionately as the most powerful locomotives, and less than the relative weight which is thought to obtain in the motor arrangements of birds.

This was applied to an aeroplane, spreading 4,000 square feet of surface, capable of increase to 5,500 square feet, the whole apparatus weighing 8,000 pounds. In a trial trip on July 31, 1894, the machine was accidentally released from the upper guiding rails, and it actually

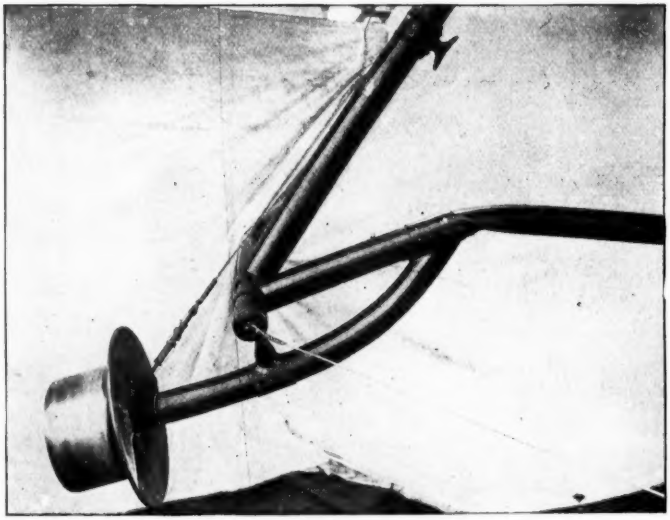


Fig. 12.

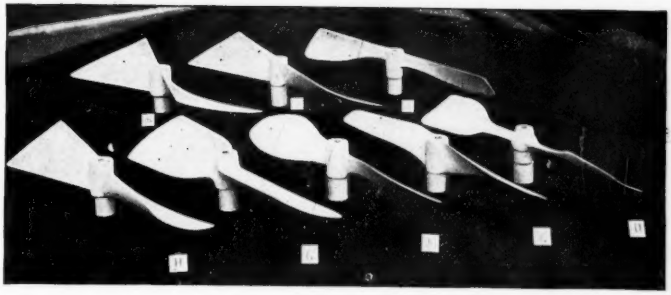
THE RESULT OF AN ACCIDENT TO MR. MAXIM'S MACHINE.

This shows one of the wheels which pulled upward on the upper rail. The lifting power of the machine caused the axle to yield as here shown.

flew a short distance. This flight being accidental, the machine soon came down and was broken in alighting, but the passengers received no injury.

The present machine is probably defective in equilibrium, and the condenser may not be adequate for a journey, but there seems to be no reason to doubt that these defects can be remedied, and that sufficient lifting power can be obtained with the motor already developed. Whether this be accomplished by Mr. Maxim, or ultimately by some-

K J I



H G F E D

Fig. 13. — A group, showing the various forms of screws which Mr. Maxim has tested. The screw J was found to be the most efficient. A similar screw K, with wider blades, did not do so well. The screw E, although very light and small, did very well. G, a screw made on the French plan, proved the worst screw experimented with. H, the same form as J, except that the blades are much thicker, also did remarkably well.

C B A

Fig. 14.

THE THREE PRINCIPAL FORMS OF SCREW EXPERIMENTED WITH.

A. — Plain screw with flat blades.
B. — Screw with slightly curved blades with increasing pitch.
C. — Screw with curved blades, compound increasing pitch.

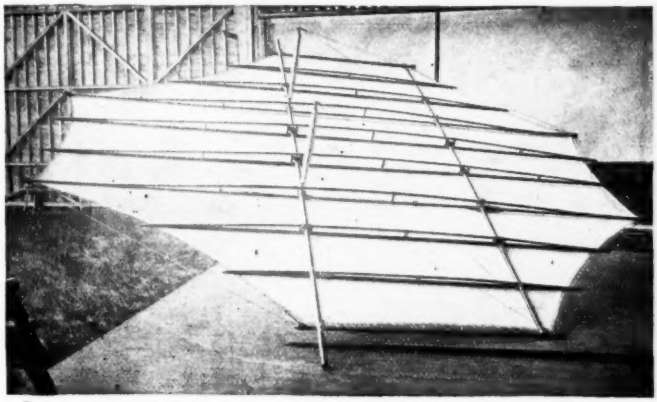


Fig. 15.

THE FORWARD RUDDER FOR STEERING MR. MAXIM'S MACHINE IN A VERTICAL DIRECTION.

This plate is especially interesting as showing the construction of the framing. — **Ed.**

body else, the former will have the renown of having produced the lightest steam engine ever built upon a large scale, and of having made it possible for man eventually to fly through the air with such a motor when the problem of safe stability is worked out. He is understood to be now contemplating the construction of a smaller apparatus.

Mr. Laurence Hargrave, now of Clifton, New South Wales, has accomplished great progress. He has built altogether twenty-one different model machines, all of which fly, and he has now produced a small steam engine weighing about eleven pounds per horse power. He has also produced a new form of aeroplane, which he terms a "cellular kite," by the use of two of which he has risen into the air when they were grouped in tandem above each other and restrained by a rope. He reports them to be perfectly stable and safe, and is now designing and building a full-sized flying machine.

In 1891 Herr Otto Lilienthal, a manufacturer of steam engines in Berlin, began a series of experiments in gliding flight with an apparatus of his invention. During the preceding twenty years, he had made many experiments, and had established the hitherto unrealized fact that surfaces shaped like the wings of sailing birds, when meeting the wind at small angles of incidence (3° to 10°), support some three to six times as much as planes of equal area at the same angle of incidence, while their forward resistance is not only less, but actually changes to a propelling component at acute angles. This discovery did much to correct the impression that enormous surfaces would be required to sustain the weight of a man, and made it apparent that an apparatus proportioned as is a sailing bird—*i. e.*, with one half to one square foot of surface per pound of weight—would probably suffice.

Herr Lilienthal then reduced his discovery to practice by utilizing gravity as a motive power, and gliding downward against the wind upon his apparatus from various heights, some hills utilized being two hundred feet high, and the longest glidings some four hundred yards. During several of these experiments he was lifted up by the wind as high as his original starting-point.

Having become expert at gliding downward, and having learned how to manage his apparatus, he next added a pair of propelling wings in front, moved by a compressed carbonic acid gas motor; and, having built an artificial conical hill, 50 feet high, near Berlin, he tested the new machine in the summer of 1894.

This modified apparatus did not perform to Herr Lilienthal's satisfaction. The motor was a complication, and the stability was not perfect. During the season of 1895 he modified the gliding apparatus by superposing one surface upon another, the connections forming keels, and with this arrangement he was enabled to increase his sup-

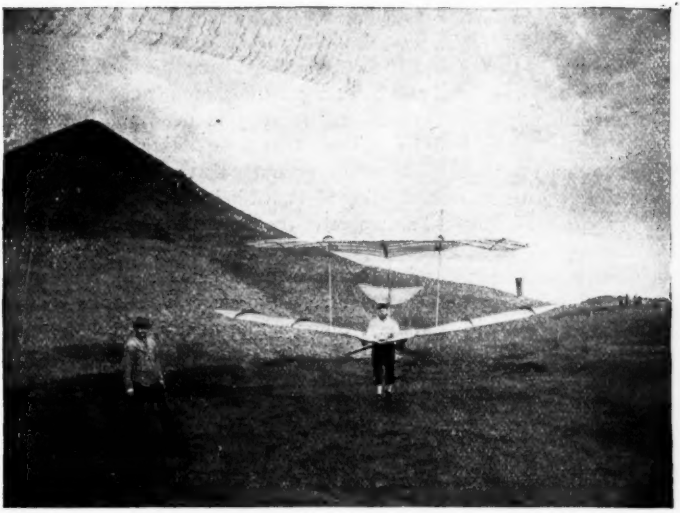


Fig. 3.

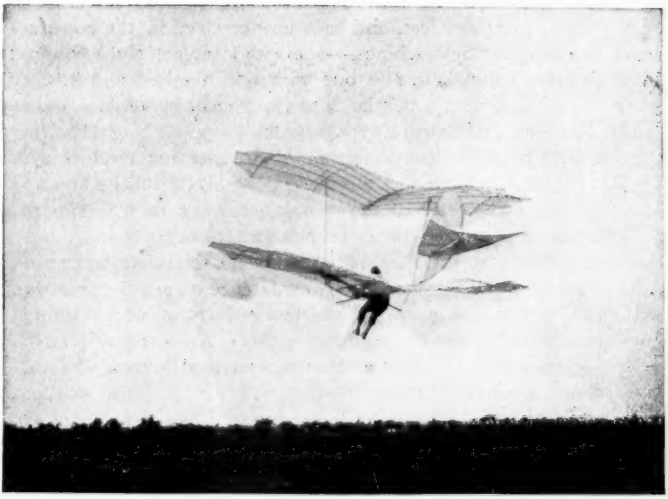


Fig. 4.

Fig. 3. Double form of apparatus constructed by Herr Otto Lilienthal. Each surface contains about 97 square feet, or, a bearing surface of about 194 square feet, with only about 18 feet spread.

Fig. 4. Shows manner of changing center of gravity, and particularly the position of the legs to the left, in order to press down the left wing, which is a little raised.

porting surfaces to 194 square feet, while reducing the spread to 18 feet. The results showed this to be a great improvement.

Herr Lilienthal also experimented in 1895 to determine the best profile for the wings, and he believes that these improvements have added so much to the stability of his apparatus that any one can learn to use it, so that downward gliding flight is likely to become an interesting sport. He has sold a number of the first types of his machines in Germany, Austria, France, and England, but the purchasers have found some trouble in learning how to manage them.

Mr. Herring, in the United States, produced in 1891 a flying model driven by twisted rubber, which automatically regulated itself in horizontal flight. In 1892 he applied the same principle to a larger model driven by an oil engine and provided with a condenser, which would raise itself into the air after running over a smooth horizontal surface. This having been destroyed by an accident, he next designed a gliding apparatus, somewhat similar to Lilienthal's, with which he took short flights; and in 1895 he produced a compact form of efficient supporting surface which seems to promise great stability.

Mr. Pilcher, in England, produced in 1895 two soaring machines, differing somewhat from Lilienthal's in design. With these he has been lifted from the ground twenty feet, and taken over a surface of two hundred or more feet, and he is now engaged in the construction of two new soaring machines,—one with an area of three hundred square feet for calm days, and one with one hundred and seventy square feet of sail, with which he is to experiment in 1896.

Mr. Mouillard, of Cairo, Egypt, who has been watching the sailing birds for forty years, has completed a full-sized soaring machine with over three hundred square feet of sail surface. With this he hopes to imitate all the manœuvres of the sailing birds and to maintain the equipoise automatically. The experiments are to begin soon.

Concurrently with these various experiments, the scientific features of the subject have been studied. A conference on aerial navigation took place in Chicago in 1893, the proceedings of which form a closely-printed volume of four hundred pages. An aeronautical club has been organized in Boston, and an aeronautical annual was published by Mr. Means of that city in 1895, which is continued in 1896, while many articles on the subject have appeared in the pages of the *American Engineer*.

It is thus seen that there has been remarkable progress since 1891. Incredulity has given way, and many keen intellects have been attracted to a study of the problem. The question which now presents itself is: what direction in further experiments promises the earliest solution? There are two paths open, both of which are indicated

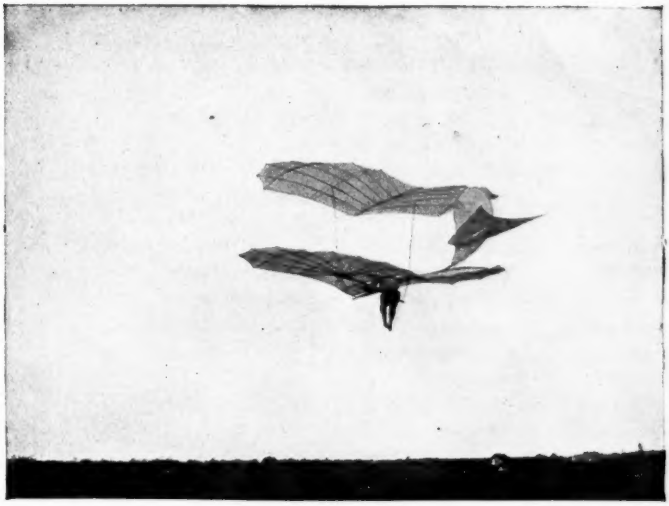


Fig. 5.

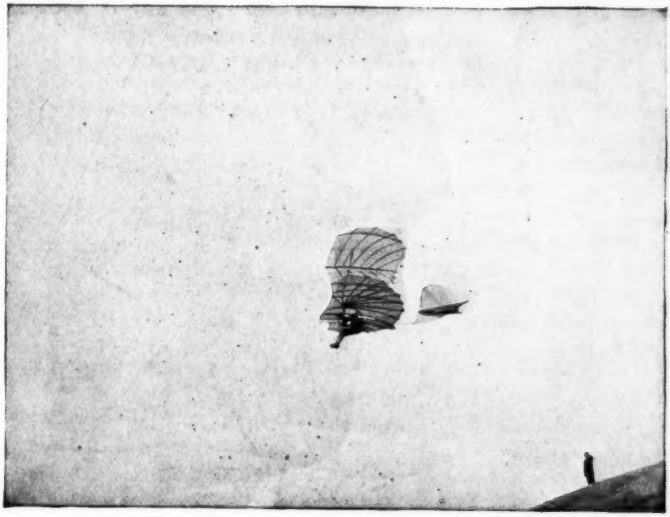


Fig. 6.

Fig. 5. Shows opposite movement to that shown in Fig. 4.

Fig. 6. The flights undertaken by such double sailing surfaces are distinguished by their great height. Left view of apparatus.

Fig. 7.

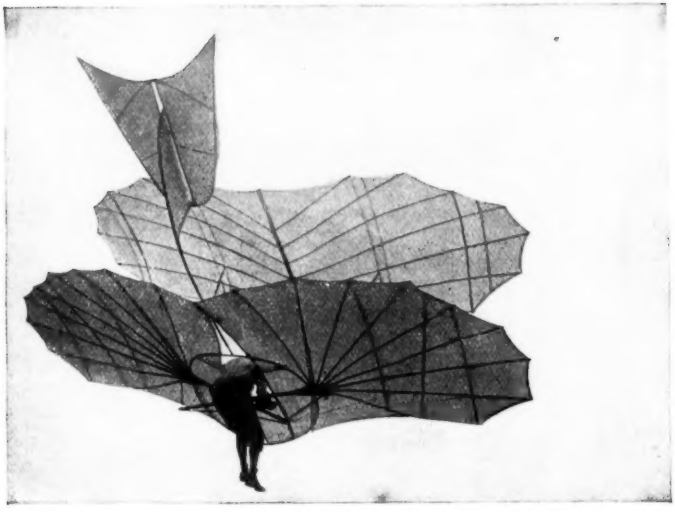


Fig. 8.

Fig. 7. The landing is brought about by raising the apparatus in front somewhat, and by lessening the speed, as shown.

Fig. 8. Shows an exact picture of the construction of the apparatus, as well as its management.

by the birds. We may either experiment with an apparatus driven by a motor, very light in proportion to its energy, and so endeavor to emulate the flapping birds; or we may try to imitate the soaring birds, who derive from the wind all the power required for flight when once they have gotten well under way.

I deem the latter path beset with fewer difficulties than the other, both because there will be only the apparatus to manage, instead of both the apparatus and the motor, and because the experiments will be much less costly, and the inevitable breakages much easier to repair.

A study of past experiments has led me to conclude that almost all failures hitherto have resulted from lack of adequate equilibrium. There have been other contributory causes, such as inadequate construction or strength, inefficient motors, etc.; but the machines have almost always come to grief for lack of that stable equipoise which the bird maintains by instinct under the varying conditions of flight and wind. There first must be safety under all conditions, in rising, in sailing, and in alighting, and it seems evident that, until this is secured, no great progress can be made towards a mechanical or a commercial success.

The ultimate flying machine will probably be provided with a motor, but it seems also probable that there will be machines for sport or for individual use, depending upon the wind alone, and that the shortest road to initial success is through the development of the latter.

Indeed, there have been before Lilienthal's a number of partial successes which might have led to a solution of the problem, if the varying essential of equilibrium had been adequate. About A. D., 1178, a Saracen (name not given) rose into the air in presence of a large assembly at Constantinople, but he soon lost his equipoise and fell to the ground, receiving severe injuries. Towards the end of the fourteenth century, Dante, a mathematician of Perugia, succeeded in soaring over Lake Trasimene; but, when he repeated the performance over the public square of Perugia, the left wing gave way, so that he fell and broke his leg. Paul Guidotti, an artist born in 1569, made use of a pair of artificial wings several times with success, sustaining himself for a quarter of a mile in the wind, but ultimately he lost his balance, fell, and broke his leg. In 1863 a Spanish peasant named Orujo was carried one league in fifteen minutes, on a rough aeroplane of his invention; while in 1867 Captain Le Bris, a French sailor, rose and balanced himself in the wind for a short time, but subsequently met with various mischances, and his means became exhausted before he succeeded in securing adequate equilibrium.

Herr Lilienthal is now far in advance of all these experimenters in the comparative safety of his apparatus, but he says and repeats that

the inconstancy of the wind is the chief enemy to overcome, whether a motor be used or not, and that the variations in the speed and direction of air currents are the principal hindrances to equilibrium in the air. And yet the sailing birds prove to us that this enemy can be overcome, that its forces, indeed, can be transformed into an adequate motive power, so that man, in a moderate wind, may learn not only to maintain his balance, but also to translate himself at will without an artificial motor.

The writer therefore suggests to those seeking a solution of the problem of flight that they should turn their thoughts and experiments in the direction of soaring flight, and seek thus to secure equilibrium and safety in the air. In other words, that they should endeavor to learn the science of the sailing birds.

Such progress has now been made, and knowledge gained, that it seems preferable and reasonably safe to experiment, after the first trials, with full-sized machines instead of models ; such machines need not be costly. Of course, proper precautions must be taken to avoid accidents at the beginning, and this may be accomplished by experimenting on a soft sand hill, or over a sheet of water. A steady wind is needful,—say, eight to fifteen miles an hour,—and the operator must acquire an initial speed of his own, either by running, by starting from a vessel under speed, or by rising upon the wind like some birds, and then gliding downward. These conditions make it preferable to select some sub-tropical or trade-wind region, where the wind may be depended upon to blow with the right intensity nearly every day. There the merits of a new conception may be experimentally tested with a full sized machine and under the constant tuition of the sailing birds, which are, in such regions, almost constantly aloft on outstretched unflapping wings.

The experimenters will doubtless meet with many failures and mishaps. They may break their machines and possibly their limbs, but there seems to be no safer or surer way of ascertaining the exact conditions which will have to be met in practical flight.

Once equilibrium and safety are attained in a wind, it will be time enough, in the writer's judgment, to add an artificial motor to the apparatus. If an aeroplane endowed with automatic equilibrium has first been developed by experimenting in the wind, methods of adapting motors thereto will be speedily discovered, and we shall reach a full solution of this problem of transportation through the air, which has been puzzling man for over two thousand years.

MODERN MACHINE-SHOP ECONOMICS.

By Horace L. Arnold.

I.—THE LOCATION OF THE SHOP.

IN a vast majority of cases the location of our large American machine shops has been determined by accident.

Almost or quite all of our notable establishments have grown from small beginnings, and the history of their rise and progress can be traced back to the employment of a very few men by some mechanic of superior attainments in the line of skill or business foresight, more often the latter than the former; and the shop where the then unknown founder of the great present industry began his long career of success was commonly located near his actual or probable customers, and in the cheapest shelter at all suitable for the requirements of the day of small things.

The founders of our large machine shops may have hoped for the successes which came to them, but not one case can now be brought to mind in which the originator of any now large, or even considerable, machine shop was in a position to choose his location and surroundings when he first began to employ workmen. The first of the name always began with a few men, in a location not specially desirable to others; sometimes there were one or more removals, as business increased; often there were none; rented premises of small area were purchased and added to, as necessity demanded or profits allowed, so that the large plant of to-day often surrounds the original site where the two or three or half a dozen original employees of the founder of the great works began their labors. Thus the old brown wooden cottage where the elder Roebling lived with and boarded his entire working force when he began drawing wire at Trenton, N. J., now stands in close proximity to the Italian villa which was later the Roebling family mansion, in the midst of the vast buildings which now shelter the thousands of workmen employed by the Roebling's Sons Company. The Italian villa with its still carefully-kept lawn and profusely-blooming banks of roses, has become the business office of the great works; the old brown cottage is a store-house; and Roebling's hands still follow the same streets to their daily toil that encompassed the little handful of wire-drawers who, under the rule of the original Roebling, slept and ate in the weather-beaten structure in the midst of the Roebling buildings of to day. Almost the same story can be told of the Allis-Reynolds shops of Milwaukee, the Globe Iron Works of Cleveland, the Baldwin shops of Philadelphia, the now diminished, but long note-

worthy, Novelty Iron Works of New York, the Birmingham Foundry of Birmingham, Conn., the Waterbury Farrel Foundry, the Pratt & Whitney Company of Hartford, and the Builder's Iron Foundry of Providence. Pratt & Whitney began to employ men while they were yet themselves employees of the Phœnix Iron Works, and their half-dozen or dozen hands were moved fron one hired room to another, until Pratt & Whitney finally cut loose from the Phœnix, and took their handful of mechanics to the Flower street bridge over Hog river, where their present shops now reach along both sides of the river, and occupy both sides of Flower street at the bridge.

It may be truly said that the great machine shop is almost never intentionally located ; it stands where its exceptionally-endowed founders first took root in a fertile business soil, and in only a few cases are the situation and buildings very well, or even well, adapted to the requirements of the great business there carried on to-day. The expense of removing a large machine shop is always great ; there are delays in business to think of before removal is decided upon ; and, above all, the enormous labor imposed upon the heads of a prosperous firm, already overburdened with the superintendence of the intricate ramifications of great undertakings, stands in the way of removal from the huge aggregation of old, dark, inconvenient shops to a new establishment planned to facilitate operations and decrease costs to limits not to be attained by rearranging and rebuilding on the old site. Hence it is the rule that large American machine shops are far from well arranged, well lighted, or conveniently located.

In some cases, however, removal is decided upon, and a few months of working double turns, and endurance of countless annoyances and vexations, leads to the ample reward of commodious, well-arranged shops and offices, where both employers and men perform their duties with such ease and pleasure that they look back and wonder how they endured the evils of the old shop for so many years so patiently. Such a case as this is to be found in the new Gates shops, in Elston avenue, Chicago. The old Gates shops had grown up from a very small beginning on the west bank of the south branch of the Chicago river to a great establishment, and had divided once, the offshoot, now the large Fraser & Chalmers shops of world-wide reputation, being located only a few squares away from the site of the original shops, although it has already removed its foundry far out on the prairie, and proposes soon to follow with its great machine tools to the same roomy locality. The Gates shops endured their old quarters until after the death of their founder. Then the young blood fled from ills they knew but too well to one of the most convenient machine shops and foundries in America for the employment of, say, five hundred men.

It will thus be seen that it is rarely, very rarely, the case that any save highly successful concerns can ever be said to really choose a shop location. Small or large, a business must be paying good dividends and must promise continued success, to warrant serious contemplation of removal.

Such removals are commonly made from a crowded locality to one where there is more space; they are sometimes made from the town to the country, and sometimes from the country to the very heart of a great city. It is instructive to briefly note one or two cases of each sort, and to consider the reasons which influenced the removal in each case.

The Garvin small machine tool building shops, then Smith & Garvin, removed from town to the country in New Jersey. After a few years in the country, Garvin came back to Center street not far from the Tombs, in New York, and later removed to Canal and Laight streets. When the firm went into the country, their most valued hands declined to follow them, and very naturally the same refusal of good men to leave the old location for the new one followed the change from country to town again. The cause is obvious; the really valuable workman is the one who forms home ties and local associations; he is in his way independent. He is not a rover, not one of the floating population; he takes root where he stops, and, after a few years of location in one spot, he has individual interests, distinct from shop interests, which make him unwilling to change either a town residence for a country residence, or a country habitation for town life. The worker who is by natural tastes and preferences better suited with the comparative quiet, seclusion, and even isolation of country life has an extreme aversion to the forced contact with the common herd which is the inevitable lot of the wage-earner in the town machine shop; in the same manner the gregariously-inclined workmen will not be contented with country solitudes. High day-pay may tempt them to make the trial, but they are soon wearied by the monotony of green fields and unpaved roads, and the deadly quiet of village evenings; they mope, grow listless first, then restless and impatient, and soon seek those city sights and sounds of close association which alone can satisfy the demands of their natures. The constant tendency of wage-workers to build up vast cities and leave the country a desert waste is ample proof that it is far easier to fill a shop with workmen of any desired grade in town than in the country. It makes little difference what part of a town is chosen for a shop location. There are always facilities for short travel; there are car lines, there are meeting- and lounging-places for the evening; and, above all, there is the liberty of town, that sweet personal liberty never to

be enjoyed in villages, which are always supervised and actually governed by a set of squeamish, over-nice, and over-zealous inquisitors, whose sole object in life is to ferret out and submit to public comment the minor failings and indiscretions of the artisan of towny instincts, whose unhappy lot is cast amid green fields and blooming lanes. So Garvin's good town men would not stay in the country, nor would their good village hands take service in Center street. From a shop point of view perhaps the country help is a shade the better. It is a little less tractable, but a little more reliable. The town help adapts itself the easier to new conditions, and is less likely to found obnoxious unwritten laws of precedent which so often make life a burden to the new superintendent of an old country shop. The one great drawback to the village shop is the inelasticity of the labor volume. The shop has a certain working force, which can not be quickly or easily diminished or enlarged. If a foreman in the country has a good man who is willing to stay, the foreman is very willing he should stay. If the foreman succeeds in organizing a good gang, or team for combined effort in a certain direction, he will exercise great forbearance before he breaks it, because he does not know how to fill a vacancy made by the loss of a specialist. In town the case is exactly the reverse. If a man does not exactly suit, he can be retired without remorse, as the employer knows that other employment awaits him, and also knows that he can find a man better adapted to his own requirements. Indeed, so far as help is concerned, there is no question in regard to the merits of town and country.

The Liberty Cycle shops at Rockaway, New Jersey, follow the machine business under truly idyllic conditions. The business demanded increased force for 1896, and the Liberty organized a new department nearly a hundred miles away from home, in Bridgeport, which is full of light metal workers of every degree. In speaking of this step, the manager referred to the difficulty of augmenting the force of Rockaway workers. First of all, the most desirable class of hands would not take temporary employment, even though they chanced to be idle, in Rockaway, where there was no other machine shop. The same men would have eagerly accepted the job, had the shops been located near other shops of the same class, so as to afford at least the chance of making the employment permanent. In the next place, such help as could be obtained in emergencies had to come from town, and invariably, after a short submission to the deathly quiet of country nights, proceeded to organize for itself diversions of a character extremely obnoxious to the sober-minded regular employees. The low, one-storied Rockaway shops, as seen in June with sweet breezes blown across the Jersey hills coming through the open windows that looked out on vistas of summer

green, seemed delightful to the casual visitor; to the harassed superintendent who could not find workmen to do his work it was a purgatory, a very fiery furnace of endless vexation and tribulation, and thronging Bridgeport caught the 1896 increase of the Rockaway shops.

The Fraser & Chalmers shops have gone four or five miles out, but four or five miles means little to a town of such distances as Chicago boasts. The new shops are still in town, decidedly. The Edward P. Allis Company Milwaukee shops do not talk of removal, nor do Pratt & Whitney, and both are examples of growth by accretion. They have found room for increased business by extension and building as occasion demanded, one year not foreseeing the needs of the next. The Globe Iron Works of Cleveland are suitably arranged for a great business where large things, like ships, are built, or even large steam engines. It is not possible in a business of this kind to make such perfectly economical arrangements for handling work as can be devised where the heaviest single production weighs only two or three or four tons, and the average weight of finished machines falls below, say, 2,500 or 3,000 pounds.

When, however, a vast business in the manufacture of large structures has grown up in different places, all under one general management, it may be very well and economically made the nucleus of a new small city wholly dependent on this great single industry. The town of Pullman, too well known to need description, is a case in point. Here is a great manufacture made to found a civic economy of its own; whether this city of Pullman, beautiful to the eye, is perfect from a humanitarian point of view is not the question here. It is an undoubted success from a manufacturing standpoint. Westinghouse is just now taking his great works to new shops in a more roomy locality ; and, in brief, any establishment with over a thousand workers can make its own town without much trouble, as it calls for a population of at least 3,000 souls resident wherever the shop is located. It is more with the shop of moderate size that a careful selection of location is a matter of great consequence to its profitable operation.

If a small plant using, say, under a hundred operatives is considered, it is easy to see that location may make the difference between success and failure. To begin with, such a concern must have its own line of special work for the general market before it can choose its location. If it depends on general work, it must be so located as to meet the convenience of its patrons ; this is the first requisite, and cannot be ignored. But, in case the shop has the country at large for a consumer of its output, then two things are essential for its survival. First : excellence of product. The quality of the output must be fully

up to the requirements of the user. No matter how perfect the foresight of the designer, or how eager the user is to purchase, or how certain the monopoly secured by the protecting patent,—if the quality of the work is not fully up to the requirements of the user, the enterprise must languish. The second requirement is none the less imperative, and is that of very cheap production, to enable such an accretion of profits to be stored as will enable the original manufacturer to compete with imitators and rivals, who, taught by his experience, are sure to spring up as soon as he becomes known.

Such a manufacturer must choose his location and his buildings and plant carefully. He must be able to secure suitable workmen at a fair price, and to place them in healthful surroundings. He must have good and competing lines of transportation. He must not have a fixed charge, for heavy trucking, between the shop and the railway or waterway, of one or even two per cent. of his sales, as is often the case. All of these conditions point to the town of at least 10,000 inhabitants as the smallest that can entice the prudent operator of a manufacturing machine shop; and even then he must be able to make his own help largely from unskilled labor by the minute subdivision of his processes. He must have a healthy and agreeable location for his workmen, who must be induced to remain with him so long as he desires, if he would secure the best results. He must have good shops, with good light, good ventilation, good sanitary devices, and in many lines of work he must provide comfortable and decent, or even refined, surroundings for women workers. It would have sounded very strange indeed to speak of women as factors in machine production ten years ago in America. We read with something like horror a few years since of the miserable lives of the English women and girl nail-makers of the first part of this century. To-day there is a constant and rapidly-increasing employment of women in the bicycle shops, and in the Hartford screw shops there may be seen lines of women and men indiscriminately mixed as operatives of the heavy hand machines. Waterbury shops are full of women who make their living in different branches of metal work; in Weston's electrical instrument factory in Newark a great many young women, among the best dressed and most intelligent in appearance of any shop-workers ever seen by the writer, can be found. Some of the cycle shops use a considerable number of women metal workers, and there is no doubt that, in the vast present increase in the demand for the "skilled laborer" class of machine-tool operators, women will be employed side by side with men, on effective automatic or semi-automatic tools, in largely-increasing numbers. In speaking of the exceptionally fine appearance of his women metal workers, Weston said he could not get good work from inferior women, and that

a lack of neatness and taste in dress and those qualities which are commonly held merely feminine, marked an organization not suitable to do the work on his delicately-constructed electrical measuring instruments. And what Weston said of women workers is also true of men workers capable of achieving the most economical production. They must be possessors of a certain degree of intelligence and refinement; bright, alert, intelligent boys and intelligent and self-respecting young women are soon to come largely into prominence in the performance of work which was but lately thought producible only by the hands of thoroughly-skilled workmen. The semi-automatic tools are changing this, and the line between the tool operator and the tool maker is becoming every day more markedly distinct. For light machine construction the owner must so locate and arrange his shops as to use women as well as men, and he must provide for the health, comfort, and self respect of his workers.

Of the wholly-isolated machine shop there are very few examples. There are one or two isolated foundries, special to the last degree of specialization, where work is made in perfection at incredibly low prices; but isolated machine shops are too rare to be taken into account. There are several isolated manufactories of large extent in the United States, which form a most interesting class study, and there are some machine shops which have gained the advantageous effects of isolation by inventing and practising special methods of dealing with workmen which distinctly separate these establishments from others of equal rank without a sacrifice of the advantages of town location.

Day wages for machinists are at this moment perhaps lowest in Fitchburg and Worcester, Mass., and highest in Toledo, Ohio; and the labor cost is in all cases the item to be attacked in the battle for low-cost machine production. Yet it does not in any way follow that the local day wage for machinists, high or low, should influence the location of a machine shop. The first requirement for low labor cost production is a healthy, contented worker, capable of continued efficient exertion, and not only willing, but eager, to give his utmost effort to advance the designs of the employer. Obviously, this condition of the worker cannot be gained by forcing wages to the lowest possible point. Great successes have clearly proved the propriety, and, it may be safely said, the necessity, of paying high wages to workers, if the greatest reduction of labor cost is to be obtained. Some system must be devised and followed which will make the unit of production the wage-producing factor, regardless of the unit of time. It is highly probable that all seeming contradictions in the machine-shop methods known to produce low labor cost work would disappear under correct analysis, and that somewhere in the productive system of the economi-

cal establishment there is always to be found a dominating factor of very highly paid labor. This factor may not affect the actual worker's pay, but it must be so placed as to directly affect the worker's output. In view of present examples, it does not seem that the locally prevailing day-wage for machinists should have any weight in the selection of a machine-shop location.

Transportation costs of raw material and finished product are in all cases fixed charges, incapable of much reduction, and are items worthy of careful consideration in connection with shop location. The industrial meridian of the United States probably does not lie east of Cleveland, and there are considerations which would, perhaps, induce a prudent machine manufacturer to decline a location very much south of Pittsburg or Cincinnati. The vast recent growths of machine-shop manufacturing in the area bounded by straight lines drawn between Pittsburg, Cleveland, Chicago, and Cincinnati, indicate clearly the great natural advantages of this district for finished metal manufactures.

The establishment of the works of the General Electric Company at Schenectady is an example of location influenced by proximity to New York and to a local iron-producing territory. The Westinghouse Electric Co. is just now taking commodious quarters near its original Allegheny location, while the Siemens-Halske takes a suburban site left vacant by the demise of the Grant locomotive works, on the prairie seven miles west of Chicago court-house.

So far the supposed vast advantage of power supplied from Niagara Falls does not cut any figure at all as a dominating factor of shop location. It is even denied that at near-by Buffalo Niagara Falls motive power can be furnished more cheaply than steam power, and machine-shop motive power is, in a vast majority of cases, a very small cost item in the grand total of production outlay.

A more extended consideration of the subject will, it is believed, fully warrant the conclusion that the character of the workers obtainable, the health and comfort of the workers, and the fixed charges of transportation of both raw material and finished product, should be the considerations deciding the location of a machine shop intending removal from its present location.

PURE WATER FOR DRINKING AND COOKING.

By S. P. Axtell.

OUR municipalities are called upon to solve no more difficult and important question than that of procuring a pure and satisfactory water-supply, by which is here meant a wholesome potable water, free from objectionable or injurious constituents, whether of mineral or organic origin.

Distillation gives us the purest water that can be obtained, but it is neither palatable or best adapted to the wants of the human system. It does not contain the mineral salts and substances necessary to give tone, strength, and development to our organisms.

Observation and experience cause me to regard all surface waters as more or less contaminated, and liable at any time to become dangerously so. They are waters that have flushed and purified our water-sheds, streets, gutters, and sewers, the latter containing the drainage from dwellings, factories, jails, and hospitals. Thus it takes up human and animal secretions and excreta, and this disgusting mass of filth, containing millions of germs of disease and death, is usually drained into the river from which the water-supply for great communities is obtained.

Ground water passing through a foul soil also is poisoned and rendered unfit for general use, though, as a general rule, it will be found pure, and any community which can obtain an abundant supply of such water should consider itself fortunate. But it is usually found to be a limited and frequently failing supply, and this fact precludes dependence upon such sources of supply for large towns and cities. They are, therefore, compelled to obtain a surface supply, notwithstanding all the dangerous possibilities of its contamination. Nor is the outlook for the future encouraging. Year after year, as the country becomes more densely populated, the contaminated condition of our streams and water-sheds will grow worse, rendering it absolutely necessary that some form of relief be obtained.

At one time it was thought that filtration might prove the solution of our difficulties, but on a large scale it is found to be impracticable. How could New York filter and purify about two hundred million gallons of water per day? The expense incurred in the erection of such a filtering plant would be enormous, and its protection, constant repair, and operation would be onerous. And then at best, on so large a scale of operation, we would have only a strained water, the filters removing only the matters held in suspension, leaving

the poisonous principles still to a large extent present for the propagation of disease. And, should an attempt be made to purify so immense a body of water by chemical action, it would certainly prove a herculean task. But why this necessity? Pure water is not required for putting out fires, for flushing water-closets, streets, and sewers, or for mechanical and many other purposes. Absolute purity is required only for such water as enters the stomach of mankind.

I do not wish to be understood in the foregoing as opposing filtration; on the contrary, I believe it should be universally used, and in such practical and efficient manner as to obtain the best results. While none of our largest cities have been willing to engage in the task of purifying and filtering their immense water-supplies, all will agree that it is perfectly practicable to purify water in small quantities. Neither do I wish to be understood as claiming that it is impossible to succeed moderately well in filtering and purifying hundreds of millions of gallons of water daily.

But, in the attempt to manipulate such immense quantities, aside from the enormous expense and trouble, there would be much more liability to imperfection and inefficiency than in manipulating smaller amounts; so that the practical business solution of this matter comes to us in the homely expression: "Would you use a hand-spike to kill a mosquito?" Or filter and purify a million gallons of water to get a drink?

After giving much thought to this subject, I have been led to the conclusion that there is but one practical remedy for this great and growing evil,—namely, the adoption of a dual water-supply system.

The question naturally arises: What quantity of pure water would be required for such a service? This can be answered only by an estimate, as no data exist upon which to found an opinion. It is believed, however, that the amount can be very closely approximated, and that a daily supply of two gallons per capita would, under proper regulations, be a sufficient quantity for culinary and drinking purposes. If this estimate is not far out of the way, New York, the Empire City, would be supplied daily for the above service with less than four million gallons of water, finely filtered and made chemically pure, bright, and sparkling.

For our future water-supplies we therefore propose: (1) to use the present system for the main supply; (2) to construct a new and pure water-supply system distinct from the main plant. The miles of pipe required would at least equal those of the main plant; but, their capacity and that of the pumping plant and reservoirs being small and the system not requiring fire hydrants or many expensive special castings, the cost of construction would be comparatively light. This

plant can be built either upon the reservoir, direct-pumping, or gravity system. The first duty would be to obtain the purest water-supply possible. Such can frequently be procured from a ground or spring-water source, but in all cases it should be given a thorough analytical test for impurities, and, if any are found, they should be removed by such chemical or electrical action as may be required. In every case its purification should be completed with a deep and thorough filtration. If the plant is to be built upon the elevated-reservoir plan, the water thus purified should be discharged from the filters into a clean covered well, at the small pumping station, and from there pumped up into a series of small connected reservoirs, constructed of such shapes and dimensions as would render it entirely practical to erect permanent buildings over the same, to protect the water from the scorching rays of a midsummer sun, as well as from dust and all pollutions which open reservoirs receive from animal and vegetable matter. Proper help should be employed to keep these reservoirs and buildings as clean and pure as an old-fashioned spring house. It is an old truism that "whatever is worth doing is worth doing well." In advocating a revolution in our water-supply service, I may recommend some features which at first may appear to many chimerical and unnecessary. Of course, they can be adopted or not, just as parties interested desire, but I believe the day has come when mankind should pay more attention to what they eat and drink, and therefore I recommend that, in connection with these reservoir buildings, a small refrigerating plant be erected, and so much of the pure water be frozen or refrigerated as may be necessary to keep the water in storage in a cool and palatable condition. The distributing and service pipes that conduct this water through the city to the consumer are usually placed at a sufficient depth in the ground to prevent any changes in temperature from materially affecting them, and, if the little service pipes, upon entering the building, were covered with some non-conductive material, it would keep the water cool in the summer, and prevent freezing and bursting of pipes in the winter.

If the system used is to be direct pumping, all constructions of the plant and all operations connected therewith would be the same, with the exception that the reservoirs would then be built in connection, and on a level, with the pumping station, and the water would be delivered from the engines directly to the consumer in the same pure and palatable condition. As the city will receive a good revenue from this pure water system, it can afford to be liberal in its construction and care; therefore, to obtain the desired sanitary result, it is recommended that the city, at its own expense, tap the pipes of this service, and run the water into every building requiring the same.

This being done as a sanitary measure, it is believed that no very formidable ordinances would be required to cause it to be universally used.

As our pure water-supply would be limited, it would be necessary to protect it from illegitimate use and from waste. This could be done by placing a very small, but accurate, meter upon every service pipe that enters a building, and charging a rate per thousand gallons that would preclude waste or illegal use.

For illustration, I propose a tariff of one dollar per thousand gallons. This, while it would give a revenue of one thousand dollars per day to the city for every million gallons used in the aggregate, would not prove onerous, for, if two gallons per capita per day should prove a liberal supply, a family of five persons could use daily ten gallons of cold, pure water at a cost of one cent,—a price that would be cheerfully paid, as they could not for that amount buy enough ice to cool two or three gallons of the dirty pond water they usually receive.

It would perhaps be well to charge or set a minimum rate upon these meters, as some, through avarice, might be inclined to use the foul water from the main plant, and thus engender disease in their midst.

I am aware that the benefits derived from this health-giving and luxurious supply would be far-reaching, not to be measured by dollars and cents.

It will be found, however, that, even from a pecuniary point of view, comparison with all other schemes results in its favor.

The cost of such a plant would vary to some extent. A competent engineer can very closely approximate the expense of such construction, when he knows the number of miles of pipe needed, the number of taps required, and the facilities for obtaining a good water-supply, in the particular vicinity. The larger portion of the system may be constructed with pipe varying in diameter from three to six inches, and a quarter-inch meter would be large enough for the service.

It is a common practice with engineers to estimate the cost of railroad and water-works constructions by the mile, when they wish to give a general or approximate cost of such a plant. I may estimate the cost of our construction at $15,000 per mile,—a figure probably much too high. It is reported that Philadelphia is contemplating the expenditure of eighteen or twenty million dollars to obtain a better water. Estimating that she has about 650 miles of water mains, and would need as much for a pure supply, the system, on this basis, would cost $9,750,000,—a saving in the cost of construction of about $9,250,000; moreover, the water obtained would be much more pure and palatable than any surface water.

Nor is this all; should Philadelphia obtain the distant supply at the estimated cost, she will have depleted her treasury to that extent.

Should she, however, adopt the dual supply, and charge for the pure water as she would be compelled to do to protect it from illegal use and waste, she would get from this source an annual income of over $750,000; and the amount would be cheerfully paid by the consumers, as they would get more than value received in the quality of the water.

There is one other fact that should be considered. The expensive foreign surface supply may in a few years become contaminated from causes not now existing or anticipated; then another source of supply would become imperatively necessary, costing as much as, or perhaps more than, the one now contemplated, and with no greater security for the future. But the dual and pure water system would settle the question of her water-supply for generations to come. Philadelphia has plenty of water in her rivers for the main supply, good enough for all such purposes, and, should she need a million or two more gallons per day for the pure supply, it could easily be obtained at small cost.

New York is expending millions in the construction of conduits and impounding and storage reservoirs, in buying lands, and in fighting the inhabitants of the Croton water-shed. Why not use the dual supply system? If the Croton water-shed becomes contaminated (as it already is), the water will still put out fires, and, if it fails to give a sufficient supply for the main purposes, a pipe could be run up the Hudson river above tide water, through which all the water needed could be pumped.

Brooklyn is differently situated from most cities in being entirely surrounded by salt water, but all she has to do is to procure her pure water-supply, and at the same time, if she cannot pump water enough out of the ponds and sands on Long Island for the main supply, run a pipe to the Hudson, where there is enough for all.

Cincinnati has been anxious for years to expend about six millions of dollars for a new surface water-supply. She has probably about 250 miles of pipe, and a dual supply would cost her about $3,750,000, leaving a saving of over $2,000,000. She has plenty of water in the Ohio river for her main supply.

Boston, Washington, Baltimore, Pittsburg, St. Louis, Newark, Jersey City, and, in fact, every city in this western continent of any importance, needs a purer and better supply, and could secure by this system corresponding savings and benefits.

I am aware that the adoption of this plan would make a radical change in our system of water-supply, but where grave and dangerous errors exist radical remedies are required.

On hydraulic engineering we depend for protection of health, life, and property, rendering it a work of vital importance. We are compelled, however, to admit that, in the hydraulic engineering of to-day, we are pursuing exactly the same plans, principles, and methods, for our water-supply, that our grandfathers pursued a century ago. There is this difference in favor of the grandfathers' work. Then the country was sparsely settled, and our water-sheds and streams were comparatively pure, while now they are polluted, and our rivers are but the open or drainage sewers of the country.

This condition has continued for many decades. Boards of health have condemned the waters as unfit for use; the press has proclaimed their vileness; physicians have warned us against their use; and our mothers, wives, and daughters have made personal appeals to the powers that be to give us, in place of the present vile pollutions, a good, healthful, bright, and sparkling water. But all to no purpose. We seem to-day no nearer the attainment of the desired blessing than we were fifty years ago.

The question naturally arises in our minds: what is the cause of this neglect, or this want of intelligent action and progress, in a matter of so much importance?

The charters of our municipal corporations are lame in some respects. A favorite charter of the present time is one in which the people elect the mayor and financial officers of the corporation, who are held responsible to them for the faithful performance of their duties. The mayor, in the fulfilment of his obligations, appoints a chief engineer for the department of public works. This appointment is made from a class of men known as civil engineers, and on the appointee devolves the duty of making plans and specifications for all construction required by the city and of giving due superintendence to the same. He is supposed to be capable of filling the positions of civil, sanitary, railway, mechanical, architectural, electric, and hydraulic engineer. The duties and requirements of each of these branches of engineering are so separate and distinct that the man had better undertake the task of successfully practising the professions of medicine and law during the week, and engage to deliver an able theological discourse on Sunday. Time and experience have demonstrated that thought given to a special subject in science or art tends to progress and perfection. It is the concentration of thought or forces that produces results.

Let our municipalities, therefore, secure and follow the advice of disinterested experts who have become distinguished in that branch of municipal engineering in which progress or reform is desired.

The hydraulic engineer should be a man educated in his profession, capable of constructing an efficient fire protection system, which, by

the way, is seldom found in our cities. How often do we hear of millions of dollars being lost for want of a proper water-supply! There was enough water in the reservoirs, but, from small pipe or defective construction, it could not be obtained when wanted. The hydraulic engineer should understand thoroughly the conditions and affinities of water, and especially should know what kind of water will benefit the human constitution.

Political parties originate in differences of opinion among men upon the true policy of the government in regard to tariff rates, banking, currency, and many other questions of a purely national character. They are commendable on the ground that they produce discussion of the principles of government. But, when such parties set up their lines in purely local elections, and assume, by virtue of their organized strength, to control the management of our municipal corporations, upon the principle that "to the victors belong the spoils," such politics becomes the bane of our social and municipal organization. The practical interpretation of this doctrine is that the ward heelers, the saloon keepers, and the political hustlers are the men who influence, and often dictate, the appointment of officers whose duties are vitally important to the health, happiness, and safety of the whole people. Who does not know of the existence of just such conditions? And who can fail to see that the system involves an enormous waste of public money, and stands as a positive bar to progress and future welfare.

Municipalities are always slow in making radical changes in their methods of conducting the public business, and it may be many years before they move in this vitally important matter. But I firmly believe that the plan here suggested, or something similar to it, must in the near future be adopted as the only remedy for our present defective and dangerous methods of procuring water-supplies.

ARCHITECTURE OF MODERN BANK BUILDINGS.

By R. W. Gibson.

II.

AFTER the study of the question of business facilities,—the reception of customers and the execution of the resultant work, as treated in my former paper,—comes the important demand for security. The preliminary arrangements of the floor, which, of course, are the prime factors in such an architectural problem as a bank building, will have been made with some attention to the placing of safes and vaults and entrances so as to prevent robbery and centralize responsibility in definite places. The cash-safe, or vault, will be placed so that the chief teller may supervise it, or, better still, the door will be arranged actually within his caged compartment. The security vault, if in the basement (as is most desirable), will be reached by a stair and elevator convenient to the officers' department, or else will be isolated in the basement by grilles allowing of continual inspection and yet preventing access. The greatest ability in planning is invited in the arrangement of easy communications with perfect security, and it must be admitted that the greatest defects occur in this particular field, even in recent buildings. The stair or passage solely for the use of clerks may very properly pass close to a basement vault-door,—it is a safeguard,—but a passage used by caterers or strangers or engineers or ashmen has no business there. Yet the most secluded vault is not the safest one. Accessibility for proper persons is to be desired, but only by special routes used for restricted purposes. These data lead to the general rule that the security vault should be placed nearly under the officers' rooms; and, as there may be occasion to use it for specie reserves (it is wise to do so, if ground-floor space is limited), a small lift is valuable, and its position may be toward that side which will favor access from the tellers' departments.

The book-vaults may be reached by the same lift, provided it is arranged at the bottom so as to open upon a hall between the security-vault and the book-vault. Many books may, however, in a fireproof building, be safely taken care of in their own departments in metallic storage cases. There has been recently much improvement in these useful contrivances. When well constructed of sufficiently heavy metal, they really stand intermediate between the fireproof safe and the antique tin box. They will resist any fire likely to occur in a fireproof

building properly furnished, and they help themselves in this direction by supplanting great quantities of woodwork in furniture. For special cases they can be made with a fireproof filling of asbestos, which increases the resistance.

The growing dissatisfaction with the practical results of fireproof construction is entirely due to lax and inconsistent practice. The quantity of woodwork usually tolerated in a so-called fireproof bank is absurd and unnecessary, to say nothing of carelessness in regard to well-known structural rules. In the really conscientious work of experienced designers these matters are rapidly being advanced. After wooden-framed walls had been rejected, came the dismissal of wooden-framed floors; now the attack is upon cabinet work and furniture. The partitions of oak paneling must go; bronze and marble are equally handsome, and do not burn. So with the wainscotings and window-jambs, the counter-screen, and the clerk's desk with cupboards and drawers underneath and perhaps a waste-paper basket as an ingenious time fuse; what better combination could be devised than this desk for the encouragement of accidental fire and the making of a quick hot blaze. An enclosed desk is almost as good as the election-day barrel. Even the counter structure is being reformed. The top must be wood,—at least for a while, until prejudices change,—but all that underneath work is condemned. The counter-top and desk-tops can rest upon open legs, or, when storage is needed, upon pedestals of metallic case work, with all the drawers and cases of steel. The counter-screen is to be built of marble, brass, and glass, as has been for some time established. All partitions and cages are to be of metal, all railings of metal or marble. Now, what is there to burn? Some of the floors are wood,—it seems necessary to allow this,—and some of the doors (very few in number) and the tops of the desks. A fire in such a place, kindled anywhere, could burn only the thing it commenced with, even if no one appeared to turn on it the handy and always-charged hose, which is the final argument and which should certainly be in readiness. So furnished, and with thorough construction, a modern bank is absolutely fireproof. The keeping out of a neighboring fire is a question simply of a good external wall. But it must be confessed that this thoroughness is very rare. It is scarcely to be called modern yet; it is the coming rule,—coming because of the repeated failures of a half-hearted handling of the fireproofing question.

Now a word as to details of vaults and safes. Let us look into the interesting devices for security against robbery. First, of course, among these is the safe, or vault, the latter name being applied somewhat indiscriminately to any large safe-keeping structure, although it

properly means an arched roof and originally implied a grand and soaring enclosure, instead of a cellar or cell. But, be it a safe, movable and of moderate size, or a vault, larger and built where it is to stand, this chief depository of valuables is to-day a steel structure of great complexity. Its powers of resistance are developed in two directions, —against fire and against robbery. These are quite different kinds of resistance. Fireproofing in the comparatively small dimensions of a vault is simple. Simplicity is its strongest quality. Nothing better can be built to resist fire than a massive arch-roofed cell of brick and nothing but brick, with double or treble walls and double or treble doors of iron so constructed as to avoid destructive warping. But against expert burglars or rioters this has small resisting power. They are defeated by entirely different materials. It is interesting to trace the modern triumph of safe-building over robbery, step by step meeting and nullifying each method of theft. The chief implements of the expert thieves who dared in the good old days to attack bank-safes were the wedge, the drill, and the explosive. The wedge, the oldest and simplest, was a dreaded assailant, and with its first cousin, the lever wedge "jimmy," could do marvelous things. These were met by an improved outside surface, showing no joints or projections which the tool could commence upon. Then the drill had its day, until it was resisted by peculiarly alloyed steel, hardened to a greater degree than the hardest tools. The explosive, used in small and repeated charges, which was the latest device of the "crooks," is guarded against by massive construction and by closest possible joints both in putting walls together and in the fitting of doors and their mechanism. Several methods of construction have been invented to meet

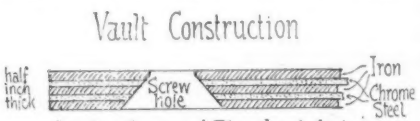


Fig 6 Compound Plate $\frac{1}{2}$ inch thick welded and rolled and tempered

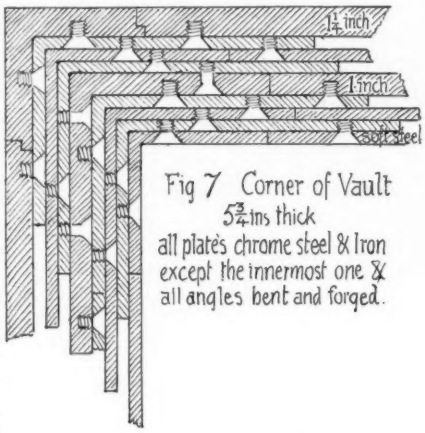


Fig 7 Corner of Vault $5\frac{3}{4}$ ins thick all plates chrome steel & Iron except the innermost one & all angles bent and forged.

these many requirements, and each doubtless has its peculiar merits. The well-known strength of the spheroid form against external force, as exemplified in the familiar egg-shell, has been adapted to this purpose. It is doubtless superior to any others against such attack as the use of external explosives in mass, or against such accident as falling with a burning building, but its circular work is impracticable for the large sizes of modern vaults, and involves large space in proportion to capa-

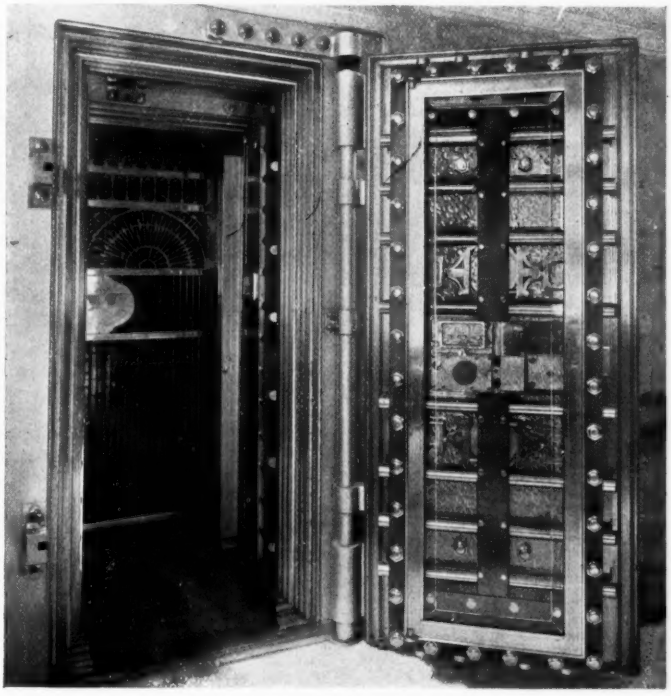


FIG. 8. A MODERN VAULT DOOR.

city. Rectangular construction affords facility for building to any size, and, as against its lesser resistance to massed force, permits of greater thickness of wall to produce the required effect. A system of solid single casting in hard drill-proof alloy is, of course, limited to safes comparatively small. Another, of building in large blocks tongued and bolted and dovetailed together, is more applicable to greater structures. But the device which in practice has been most

extensively used, and which may, therefore, be assumed to have been found most reliable in the opinion of the bankers, is the composite steel plate built up in layers to any required thickness. Each plate (from a half-inch to one and a quarter inches in thickness) is composed of five layers, three of tough iron (contributing strength) alternating with two of chrome steel, furnishing hard brittle drill-proof layers in the substance (Fig. 6). These are welded together and rolled to even thickness, then fitted and flattened, and finally tempered. They are then built up in the walls, bottom, and top, of the vault, or

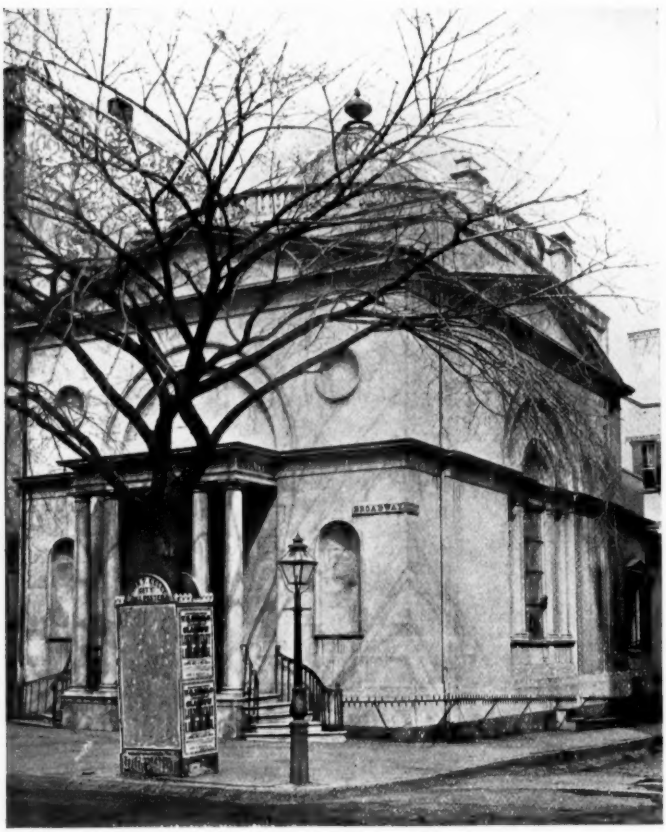


FIG. 9. THE OLD MECHANICS' AND FARMERS' BANK, ALBANY, N. Y.

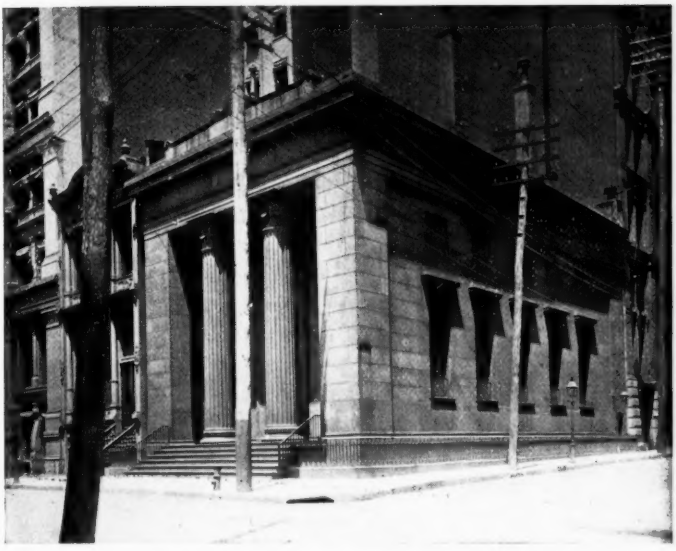


FIG. 10. BANK OF AMERICA, NEW YORK.

safe, by commencing with the outer layer and screwing the next on it, from the inside, with bolts of similar compound material which do not go through to the surface. Each successive layer covers the heads of the screws of the last, and of course each breaks joints. An ordinary good vault has perhaps three inches of such construction, an exceptional one four or five inches. The vaults of the New York Clearing House, the heaviest yet built, have six and a quarter inches. The attack upon the older forms of this work was usually at the angles where the edges of all the plates met, where an explosive might open a joint slightly, and the wedge and jimmy gain an entrance to pry off plate after plate. But such assault is rendered impossible in modern work by making the outer and inner angles forged and bent, removing the assailable joint. Fig. 7 illustrates this construction as applied in the best work, with all the plates bent at the angles and all the corners forged in box-form of three angles meeting.

The next important attack frustrated was the drill. Any ordinary metal can be drilled with quietness and comparative ease, and with not very cumbersome tools. But chrome steel, sandwiched in the substance of the wall, in from six to twelve different layers, defies the hardest tools. Although the temper may be drawn to make the steel

drillable by the oxyhydrogen blowpipe, this is hardly a sufficiently portable contrivance to be considered available for burglary. Against the blowpipe thickness of wall is good protection: as soon as the drill has worked a hole of moderate depth, it becomes almost impossible to maintain the draft of the flame in the narrow limits, and its power is gone. The door is usually made in the same manner as the wall, but somewhat thicker, because a small hole in the door in the right place may give access to the mechanism of the lock and allow an opportunity to throw the bolts, which are carried on a separate frame on its inner surface. An illustration of a good modern vault-door is given in Fig. 8. The door being sufficiently thick to defy front assault, the burglar used to attack it in flank. He endeavored, by the use of explosives, to start the plates at a corner, just as in an old-fashioned safe he attacked the walls, using the wedge to enlarge the crack and peel off the plates. This is the point emphasized by the makers of round doors; it is scarcely a weak point, yet the writer suggests that it might be well in rectangular doors to cut off the corners to octagon form with an angle gusset piece of about eight inches, so that the dog's-ear piece, the weakest spot, might be obviated, and yet the useful shape of a natural door be retained. But time is too short for a robber to get in, even by a square angled door of a modern vault. It is a hopeless task. He will perhaps try to smash a spindle which occupies some hole in the make-up of the door; there are, of course, holes where the combination spindle, or where the lever which throws the bolt, passes through. If one of these can be driven in or out by an explosive, he may pick the lock. But now this, too, is guarded against, by using cone-shaped spindles with flanges. It is undoubtedly a fact that a modern vault is unassailable by any method available to a burglar in the limited time at his disposal. Where extraordinary strength is wanted, as, for instance, in a national treasury, or in a place where an armed mob or invading force might have to be held at bay, it would seem that the laminated construction might be combined advantageously with a greater mass of elastic steel forming a core eight inches in thickness, with drill-proof layers of three inches more inside and out, which would give a greater resistance, resembling that of armor plate, to massed explosive force. In vault work there are other recent inventions, description of which space does not permit, such as the time-locks which can be opened only at certain predetermined hours, and automatic time-locks which from within unlock the door at the required hour without the aid of a spindle, and so avoid the hole through the door which it requires. Then there are movable platforms which cover the necessary raised sill of the door so as to afford a level entrance,—

FIG. 11. THE NEW YORK CLEARING HOUSE.

a great convenience in a busy bank or safe deposit company,—and the net-work of electric wires which, enclosing every inch of the vault, rings an alarm in some outer place, in case any perforation is made in the enclosing skin.

Next on our assumed schedule of a bank's purposes in a modern building we mentioned reputation and prestige. To these architecture contributes in the highest degree.

FIG. 12. OFFICERS' DEPARTMENT, NEW YORK CLEARING HOUSE.

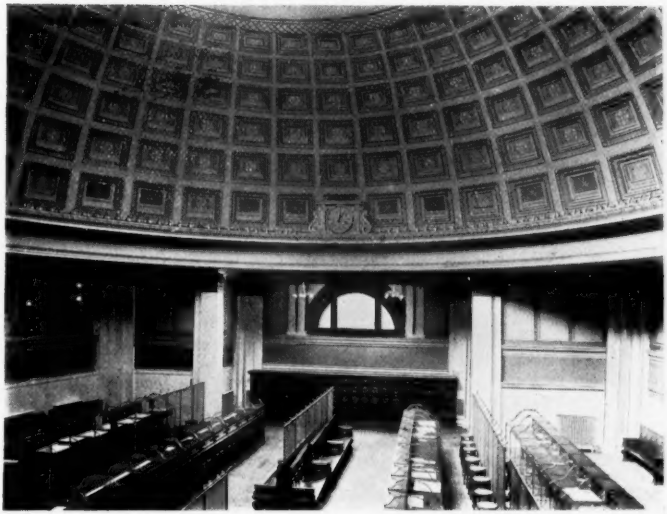


FIG. 13. EXCHANGE ROOM, NEW YORK CLEARING HOUSE.

One of the characteristics of good architecture is that the edifice should announce its purpose. This does not mean that it should advertise itself in clamorous fashion, but in the old language of art—that language in which are written not proclamations, but sermons, in stones—it should unassumingly tell its story. A church should, by its artistic expression, be evidently a church, whether Gothic or Classic or Modern ; and similarly a bank should be recognizable as a bank, if it is to attain to the rank of good architecture as well as good building. It scarcely reaches the dignity of which it is worthy if it merely goes as far as to indicate a business building which, while clearly not a residence or a temple, might be a nest of law-offices or a warehouse. It is in this direction that architecture is to be urged as worthy of more recognition at the hands of financial corporations. To the bank reputation and prestige are of vital importance. An institution which exists to extend its own well-known credit for the protection of its customers' less known credit (a good definition of banking) benefits not only by actual strength, but also by the appearance of strength. Reputation depends not only upon simple solvency and ability, but also upon the outward expression and understanding of these real qualities.

How, then, should a bank be architecturally recognized? What type of building is characteristic of its peculiar virtues? It must be

FIG. 14. GREENWICH SAVINGS BANK, NEW YORK.

confessed that the answer is not readily given ; the question is one long neglected, and only vaguely understood. Yet it has been, and will be, more prominent. In the earlier days of American banking there arose in the older cities buildings which housed the more notable institutions, which were unmistakably banks and dignified examples of good art. The old Mechanics' and Farmers' Bank, of Albany, shown in Fig. 9, is a good representative of the class. It disappeared nearly twenty years ago ; the bank built a new house, larger and more convenient, and the old one made way for a new post-office. There were then a good many of these admirable buildings. The Old Bank of America (Fig. 10) is another example. It was built in 1835, a year when several similar structures arose in the chief cities. It gave way to a large office-building about five years ago. These bank-buildings have nearly all gone. But why has the type been abandoned in their successors? Their art contributed to and expressed the prestige of the bank at a time when each business venture stood more alone and self-contained than now. The modern office-building was the element which disturbed these conditions. When these giants of commercial enterprise began their successful career, there gathered upon their pioneer examples a greater prestige than seemed to pertain to any less prominent structures, and a bank which housed a whole

village of enterprise gathered fame in doing it. But big office-buildings in many cities have ceased to be distinctive, and the bank no longer earns prestige therein. And in some places where much competition in office-renting prevails and modern buildings are numerous it has become a somewhat less tempting enterprise financially. So that we naturally see now a tendency to return to the older precedent. It is true that circumstances may often demand the office-building, and that, properly treated, it may be artistically as true and good as the other class, although never of such marked character.

The value to a bank of a location where land is valued upon a

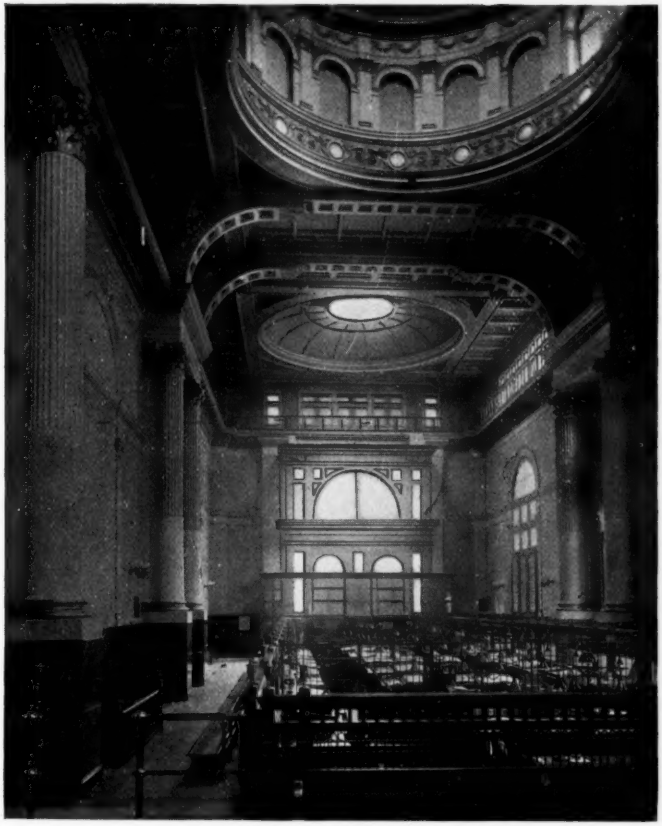


FIG. 15. INTERIOR OF GREENWICH SAVINGS BANK.

"many-storied" basis may sometimes compel the alternative of a sacrifice of either revenue or individuality, and the choice may be impelled toward reaping the more tangible harvest in rents; yet sometimes it may fairly be questioned whether this revenue is not of less value than the security and convenience with the reputation and prestige made possible by a building essentially and entirely a bank.

FIG. 16. BANK OF BUFFALO.

The subject is worthy of discussion. In the question of style the author ventures to support continued return to that distinctive type of bank which is recognized in so-called Colonial architecture by its classic proportions, its substantial, cultivated architectural detail of Renaissance style, its refined orders, and its graceful and reposeful domed ceilings and roofs. The New York Clearing House, of which

a view is given (Fig. 11), is an example of an effort in this direction. In this instance an unusually rich treatment is accorded to express the responsibility assumed by such a building, representing the united banks of New York city,—the chief focus, in fact, of those interests in the United States To stand worthily as the public manifestation of such a community, a building must avail itself of the highest and richest expressions of art, and must preach, not simply the utilitarian idea, but also a public spirited generosity and pride. Its site in the crowded and densely-built section of the metropolis, where observers are close to its walls. dictated a grand simplicity of composition, and

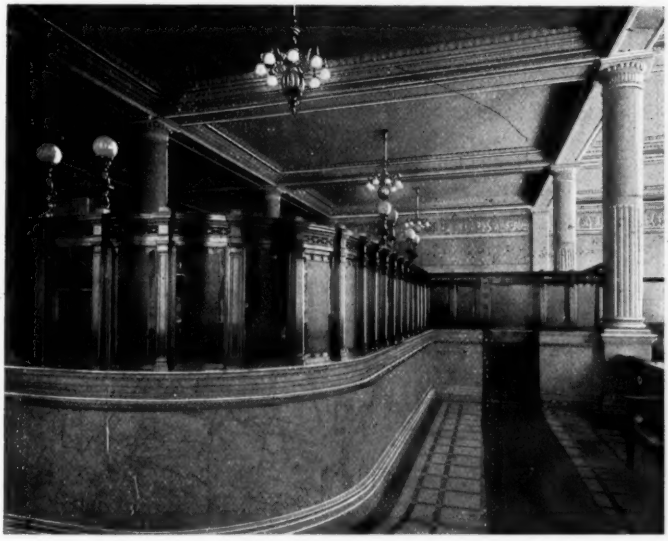


FIG. 17. COUNTER SCREEN. CHASE NATIONAL BANK.

at the same time a delicacy of detail. But there is no sacrifice of its useful purpose to ornamental effect. The windows are of great size; the exterior is the outgrowth of a plan devised for work. Within, the purposes of the building, unhampered by any demands for general tenancy, permitted of an artistic development of its own character. Its interiors are architectural as well as its façade. The manager's office (Fig. 12) and the clearing room (Fig. 13) are shown, to illustrate the individuality made possible by the lofty ceilings and regular spaces of a building designed for one purpose only.

It happens that the savings banks are to-day doing the foremost

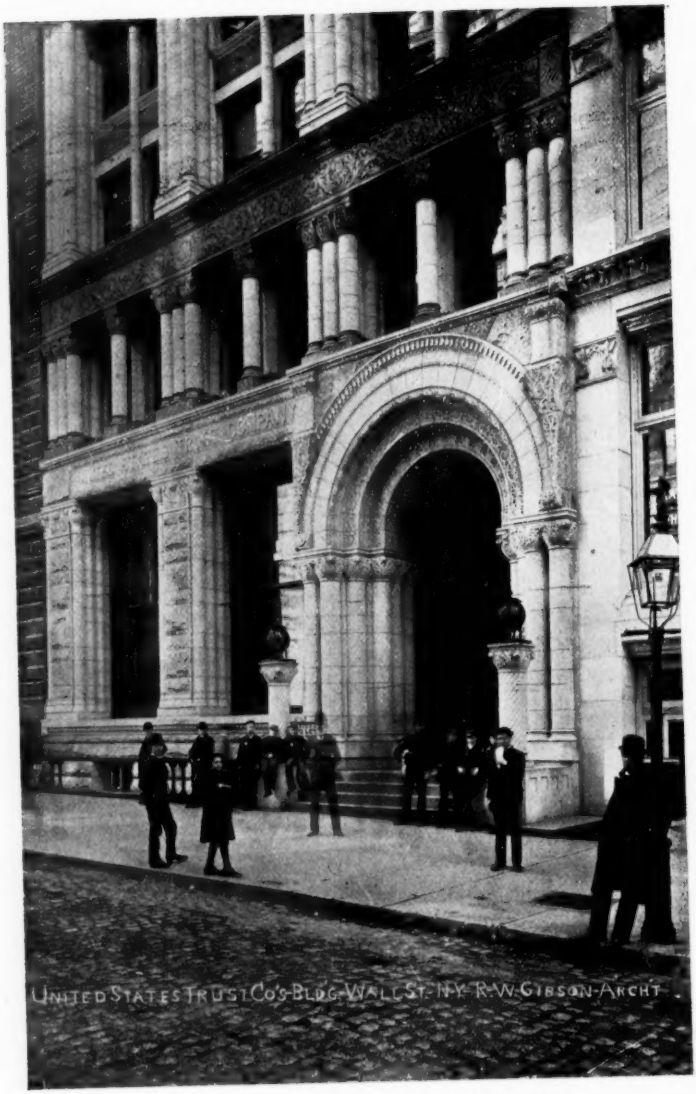


FIG. 18. UNITED STATES TRUST COMPANY'S BUILDING.

work in the cultivation of bank architecture. Owing to their peculiar circumstances, they find advantage where some other institutions are deterred. Commercial banks necessarily select for their reserve assets those investments which are easily convertible to use when needed, and only a fair portion of a considerable surplus can safely be devoted to such a "slow" asset as real estate of valuable character. Occasions may arise when the strength of the strongest bank is so taxed that not only the value, but the immediate availability, of its property is desirable. But the older savings banks, under their system of safe-keeping, have to deal with different conditions. The funds they receive are the *reserves* of their customers,—not their working capital. With their comparative security against urgent haste and panic, they can well afford to put part of their surplus into just such assets as land and buildings. The low rate of interest on the capital absorbed is compensated in the absolute security it offers. In short, every inducement which the commercial bank finds to build its own house is doubly strong for a savings bank.

We see continued work in this direction. The Greenwich Savings Bank, New York, having outgrown a building of the last generation, has erected that shown by Figures 14 and 15. It is a single great hall, with light on three sides and through the domes of the roof. Its dimensions—150 feet by 50—make its interior impressive, apart from its architectural features. The height is 65 feet,—more than is actually necessary internally, but desirable externally to give the building dignity among adjacent structures. The vertical character of our modern city buildings compels a revision of the system of proportion in street fronts. What would appear admirable in unprejudiced position might be dwarfed or distorted by association with the extreme contrast of lofty towers. Of course, there are several rooms of ordinary size in such a building as this; they are placed in a separate wing, which has four stories in the same total height.

The Bank of Buffalo (a commercial bank), shown on Fig. 16, is a building of the old type, modified for present conditions. To give it sufficient height to hold its own among lofty neighbors, as well as to make available a somewhat limited space, a second story is provided for directors' and other separate rooms, and the high dome which gives character to the edifice affords much valuable space.

A view of a part of the interior of the Chase National Bank, New York, is given in Fig. 17, which illustrates some of the new features, especially the absence of woodwork and the use of marble and bronze in its place.

As an example of a banking-room in connection with a high office-building, the view (Fig. 18) of the United States Trust Company's

office in New York is given. A story of about twenty feet in height serves to distinguish the chief portion of the edifice from the parts which are rented, and an extremely massive and solid treatment of the granite pillars and arches expresses the qualities of permanence and strength.

Last mentioned in our list, but by no means least important, of the aims of a well-designed bank-building is comfort. The appliances for this purpose are less specialized, and are known by their use in many other buildings. Good ventilation is a foremost need. In the best modern work, it is made independent of the heating. The registers are for fresh air, not hot air. In winter it is, of course, warmed, but the heating is left to local management by direct radiators, or, better still, under control of automatic thermostats. Fans must be provided; they are the only positive producers of air-currents, and even these are usually neglected by ignorant engineers. Now that electricity is so generally available, the author advocates local control for these also,—several separate inlet and outlet fans of small size, which can be started and stopped by a push-button just as the light is managed. The usual way is still to collect the numerous ducts in a system, and lead them from or to a large fan. Lighting has many new appliances. It should be switched in distinct groups for use apart from other groups, and a special desk-light or counter-light should be provided to each individual. The electric elevator must also be noticed. It is superior for bank-work to the hydraulic, on account of its greater cleanliness, and also because it will stay where it is left, level with a floor,— an important quality if trucks or loads of heavy books are being handled on it. An elevator makes a basement under a chief department, or a gallery over it, nearer and more convenient than remote space on the same floor. It makes an attic a better storage-place than a basement, and equally accessible. It allows directors' rooms and other little-used departments to be put off the main floor where space is limited. It is invaluable. The desk telephone, too, is indispensable. This and the electric buzzer need no more than mention. Occasionally the pneumatic dispatch tube is a great labor-saver.

Outside of working departments, a modern bank will have much space devoted to its employees. A dressing-room is provided with a locker for each man, and sometimes, if space permits, a few gymnasium fittings; a dining-room, with pantry and caterers' entrance and conveniences in the basement, or with a kitchen with refrigerator and store-rooms, the latter arrangement usually in an upper story; and a room where one or two employees may sleep, if urgent night-work is demanded; and indeed more things than can here be mentioned.

DETERMINING THE VALUE OF AN IRON MINE.

By Nelson P. Hulst.

IN determining the value of an iron mine, one must apply very largely the rules or principles which are used in estimating the value of mines of the other metals; or the broader statement might be made that one must apply very largely the rules which are generally used in getting at the value of any other kind of mine. For, while every mine has more or less distinguishing features which affect most vitally its value, there are certain features common to all mines, which compel the effort to arrive at their value to conform to general lines. The standard by which the valuation must always be gaged is the earning capacity of the mine, the common standard which is used in estimating the value of any species of property. It will not do, however, to accept as an evidence of the earning power of a mine the cost-sheets or balance-sheets of its office. The system of accounts kept there must be thoroughly investigated, if the evidence of the books is to have any weight in determining the value. Either through heedlessness or by purpose, sometimes the balance sheets may show, or may be made to show, a gratifying profit in the mining work, by continually charging up to the inventory account, at full cost, the machinery and the various permanent improvements required for the business. Although these are thus made to appear as assets at full value, without qualification, the veriest tyro in the business knows, or ought to know, that their value is only that of tools which are steadily wearing out, like the shovels or hammers, or are becoming obsolete and must soon be abandoned for more economical ones which will place the mine at equal advantage with competitors, and that, in the event of the exhaustion of the mine, they can, at the very best, have only a tithe of the value accorded them in the book accounts. Nor, on the other hand, will it do to say of any mine that it is worthless because it has shown a debt-producing capacity, for the most superficial examination may show the unfortunate combination of a valuable mine and a poor manager. Judgment of a mine must, therefore, sometimes be independent of its existing management as well as of its books of account.

For the reason that there are a number of factors which go to make up the value of a mine,—factors which differ as mines differ, no two ever being just alike,—it becomes of moment, and it ought always to appear especially necessary to those purposing to invest in mines, that men of known capability in weighing the importance and relative weight of the several factors which limit the value of a mine should be

selected to determine the value. It is in place here to enumerate the more important factors which affect the value of iron mines. They are as follows: magnitude of the ore body; accessibility to a point of consumption; market value of the ore; its chemical and physical qualities; freedom of the ore body from rock masses, as well as from lean or less merchantable ores; local relations affecting the mine; amount of water to be dealt with; timber supply. There are other less important conditions affecting the value of a mine, which cannot be so accurately estimated, and are not considered in this article, although they should have their measure of influence, small as it may be.

No attempt has been made in the enumeration here given to arrange the several factors in the order of their merit, as the relation of one to the other may be said to change with almost every mine. This difference in the relative importance of the several factors especially distinguishes iron from precious-metal mines. Accessibility to a point of consumption is always of the greatest importance in valuing the former; it has very seldom more than slight consideration when valuing the latter. As all know who are at all familiar with mines, it is a matter of minor importance, when considering a precious-metal mine, whether its location is within the bounds of civilization or at the ends of the earth, whether it is among the clouds or at the bottom of a river-bed, so long as the quality of its ore, its richness in the metal sought for, sufficiently exceeds in value the cost of its transportation. The cost of transportation may seem appalling, but it is, in fact, often a charge of inconsiderable weight compared with the tonnage of ore producing it; and, when it appears in mine costs distributed over this tonnage, it becomes an almost unnoticeable amount. The product of an iron mine is not thus reduced in weight by concentration. The freight charge it bears is on a very bulky material in comparison; and, while it is a commercial necessity that this transportation-cost be small per ton, it is in effect often larger than what appears as a freight charge in the distribution of such cost over the tonnage of a precious-metal mine. As freight costs on iron ore make up so often a very large part of its value, the accessibility of an iron mine—*i. e.*, its location at such a point as to command a freight cost on its product within the allowable limits—must be of chief importance. When an iron mine is so situated that the transportation of its product cannot be had, or cannot be hoped for, at such a rate per ton as will allow a satisfactory profit in the mine work, it is practically worthless.

There is the further difference between these mines that the product of the one (gold) has a stable value, while that of the other fluctuates. In times of financial depression, the former is affected profitably; the latter suffers in such seasons early and late. Although

there are many complex problems to be encountered in attempting to arrive at the value of a precious-metal mine, it may be said that there are many intricate perplexities attending the labor of estimating with a fair measure of accuracy the value of an iron mine.

No argument need accompany the statement that the magnitude of an iron mine is of very great moment when considering its value. It is essential, however, to note, as between a large mine and a small mine, where the other conditions affecting value are relatively about the same, that the former has a value, when compared with the latter, in excess of the ratio of size. To simplify the argument, let us consider, not two mines of different size, but one mine producing different tonnages annually. The deductions made under such conditions, it is fair to believe, are equally applicable to mines of different sizes. To state it in the simplest terms possible, the value of a mine is just equal to the total available tonnage it can produce multiplied by the average net profit obtained on each ton of product and no more. The net profit realized on each ton for any one year is the difference between the cost of its production and the selling-price of it for that year. Always as a part of the cost of producing the ore, there are some expenses appearing on a cost-sheet which remain fairly constant per ton for a given tonnage. These are called fixed expenses, and include superintendence, office expenses, insurance, pumping, and certain labor at various points both on the surface and underground. If these fixed expenses for a product of 200,000 tons per annum are, say, 15 cents per ton, it is clear that they would be 30 cents per ton on an annual product of 100,000 tons, and just as clear that they would be 7½ cents per ton, if the product were increased to 400,000 tons per annum. It is to be noted also that the expenses incurred by very much of the dead work of a mine, as the sinking of shafts, driving of levels, etc., when distributed over tonnage product, are subject to the same rule that governs fixed expenses, with reference to increased or diminished tonnage. It is only a reasonable deduction from the foregoing that the ore product from a larger mine can be produced at a less cost per ton, and hence the larger mine should have value accorded it in a ratio greater than that represented by its difference in size from the smaller mine. This being the case, it is evident that, in estimating the value of a mine, different figures must be used according as the mine is large or small.

In arriving at the magnitude of an iron mine, if the development be supposed to be complete, the measurement of the ore reserves may be readily made, and the total tonnage computed therefrom when the specific gravity of the ore is known. But the tonnage thus computed cannot be accounted the total available tonnage. By no system of

mining is it possible to remove all the ore, a greater or less percentage being wasted in the process of mining; nor are ore bodies usually free from rock masses. What allowance should be made for the ore lost in mining, or because of the presence of rock or of lean, worthless ore considered as rock, must be most carefully determined. If one is unfamiliar with an iron ore district where the mine to be valued is located, it is often a necessity that he study diligently both the ore and rock masses occurring in the mine. This is essential, as the ore of every mining district has distinguishing characteristics, and the same may be said of the rock occurring with the ore, which differentiates both of them from those of other regions, and which, if not fully appreciated, will lead one into error. Where the development has not been sufficiently complete, further development of the ore body may be necessary; and, if the expense it would involve cannot be incurred, then one must make the best study possible of near-by mines in the district, if such exist, to learn of the frequency of occurring rock in their ore bodies. In some instances the rock-dumps afford an indication of the prevalence of rock in the ore, which may assist one to some conclusion as to its percentage in the ore body. Each mining district is also more or less a law to itself as to geological features which affect the occurrence of and limits to ore bodies. In the Gogebic district of the Lake Superior region the prevalence of a system of dykes, great tilted planes of rock intersecting the ore bodies, are a notable feature. On the Menominee range of the Lake Superior region the lenses of ore exhibit a westerly pitch so generally that it is a characteristic for the district. The other so-called ranges of the Lake Superior region have also their peculiarities. Hence, in arriving at the magnitude of any ore body, there must be a proper knowledge of the geological features which are likely to affect it.

The factor of accessibility has already been considered in another connection, but it may be said further that in all cases accessibility is to be measured by freight costs only, not by miles of distance. The iron mines of the Mediterranean are very often more accessible to Atlantic coast furnaces than are the much less distant Lake Superior mines. Freight rates, moreover, should always be estimated by the percentage of iron the ore contains,—*i. e.*, the iron units. In thus considering freight rates, it appears that quality of the ore also must be considered in ascertaining the limits of accessibility of a mine.

The market price of iron ore necessarily affects the value of the mine producing it. For many years it has suffered frequent fluctuations in response to the ever-varying prices of iron and steel. This factor of market price of the ore, which determines the possible profits of mining and therefore the value of the mine, must be, not to-day's

price per ton, or last year's, but the average price, as near as it may be ascertained, for such a period of time as may be judged to cover the profitable activity of the mine. The drift of business is to lower profits as individual enterprises grow larger. Within the past two years the market price of Lake Superior ores has sounded the lowest depths ever reached by them,—a price which meant dire loss to many mines. The price for this year may show a rebound of a dollar per ton, but this does not mean that such increase is all profit to the mine operator. Increased wages and increase of freights, as well as increased cost of supplies, make up a portion of the difference in price. To be able to compute with any degree of correctness the average price of iron ore for a period covered by the future, one must needs be a seer. But one can, without assuming such a *rôle*, read the signs of the times as indicating in all directions a trend to lower prices. It is a natural inference that the profits per ton in mining iron ore in the Lake Superior region are also likely to tend to a lower figure, especially when one observes that its most promising mining properties—*i. e.*, the mines now producing, and others likely to produce, the major portion of the ore—are becoming absorbed into the control of a few corporations. As these corporations have diminished in number, the mines which they control, where capable of it, have been pushed to an increased annual output. A single mine in 1892, the Norrie of the Gogebic range, produced 985,000 tons of ore, while, but twenty years earlier, all the active mines of the Lake Superior region, twenty-nine in number, produced but 949,000 tons. As showing how mines are beginning to be pushed for large annual output, it may be stated that for the year 1895 twelve mines in this region produced a total of 5,200,000 tons, or half the entire production, and some of these giants are just gathering their strength. It may not be safe to say for a decade hence that the product of less than twelve mines will constitute the major portion of the annual iron ore output of the region, but it seems entirely within bounds to make the affirmation that a very considerably less number than twelve corporations will control mines which will produce the major portion of it. It is still more reasonable to expect that this production of the major portion will be accomplished with greater economy of cost per ton than at present, and that a less profit per ton will satisfy; and this appears the more reasonable when it is considered that these fewer corporations will have other profits coming to them from the transportation of the ore, if not also from its conversion into metal. Other reasons could be recited, but they cannot be included in so brief a paper. A figure, therefore, which might be expected to represent the average profits on iron ore to be used as a factor in valuing an

iron mine should, since it must depend entirely on future prices, be made a comparatively small one to insure a safe investment. But the valuation of a mine sometimes includes the fee of the property. In such instance the risk in the business is wholly on the part of the investor. When, on the other hand, the valuation is to be of the leasehold and improvements, if any, together with a bonus large or small, as the case may be, the risk is diminished, for the reason that the fee-owner shares with the mine operator in a part of the hazard attaching to a mining investment. For a valuation in the latter case, it is enough to determine whether there is a sufficient quantity of ore in the mine, as well as whether there is the certainty of an ample average profit from it which will more than make good to the lessee his expenditure for the lease and for such equipment as it may require.

The chemical quality of an iron ore is an important factor in determining its value, and in consequence that of the mine producing it, since iron smelting has attained to the dignity of a science by the precision of its work. The capable furnace manager of to-day either is an intelligent chemist or has at his command a chemical laboratory staff. Iron smelting is conducted by him with all the exactness of a laboratory experiment, so far as ores, fluxes, and fuels are concerned. To this end he must have an accurate knowledge of the various percentages of all the elements contained in an iron ore which will affect the quality of pig iron, as well as the slag-making constituents the ore contains. The higher the percentage of iron contained, the greater is its smelting value, except as it is limited by the character of the oxidation of the metal in the ore, it making a difference whether the metal exists in the form of a magnetic oxid or a sesquioxid. Phosphorus must be limited to a certain small percentage, varying with the use to which the pig iron is to be put. Sulphur is never admissible except in small percentages, unless it can be economically eliminated before reaching the furnace. The percentage of slag-making constituents of an ore affects fuel consumption and in so far as they enhance the freight on the units of iron contained in the ore, affects also the value.

The physical quality of the ore, so far as it affects the cost of smelting, affects its market value. A score of years ago it was almost a necessity that the operator of a mine producing soft hematite ore should have control also of a mine producing hard specular ore or magnetic ore, whereby he might be enabled to compel purchasers of the much-sought-after hard ores to accept with them from ten to fifteen per cent. of the much less desirable soft ores. A revolution has taken place in the ideas of blast-furnace managers as to the comparative value of hard and soft ores. Costly plants of crushing machinery have been

installed at several of the largest hard-ore mines, mainly that their product may be made thereby to approach more nearly the desirable quality of easy reducibility possessed by the soft ores.

The writer quotes with justifiable pride from a pamphlet he wrote in 1875 presenting the claims of the soft-ore bodies of the then undeveloped Menominee range, to show his early conception of the relative values of the hard and soft ores of the Lake Superior region as affected by the cost of smelting them. "I call your attention particularly to the texture and quality of the samples of ore sent you. The distinctive feature of their open porous condition characterizes them advantageously as wholly unlike the hard ores of the Marquette district. They, as you know, are dense, close-grained in texture, and to such a degree impermeable to the reducing gases of the furnace that they are smelted with difficulty. Especially is this the case with magnetic ores. So, too, the friability of these Menominee (soft) ores, which renders mining easy and economical in all its details, and reduces expense upon them even to the last preparation of the ore suitably sized for charging into the furnace, accords a value to them not possessed by the hard ores mentioned."

The hardness of the ore produced by a mine affects materially the cost of mining it. Drill work becomes greatly more expensive as the ore grows harder. Not only does the labor cost of drilling, per foot, increase, but more power drills, more drill steel, more blacksmith and machine shop labor, more explosives, and more waste of time by powder gases, are found necessary to produce a given tonnage of hard ore than are required to produce an equal amount of soft ore. The ore broken by blasting comes down often in masses requiring block-holing and sledging before it can be loaded on cars, and much of it must be lifted into cars by hand rather than by shovel, all of which adds to the expense of mining; and then follows the final cost of crushing, before referred to. The expense of timber and timbering may be at a minimum in a hard-ore mine, but this economy is far outweighed by the economies attending the mining of soft ore.

The freedom of an ore body from rock masses and lean ore permits the application of the maximum of labor on the products ought. Not only is the mine labor more effective, because not wasted on useless material, but the straight-ahead work allows a systematization of it which insures the highest economy. Where rock masses occur, their avoidance, or their penetration in the prosecution of the so-called "dead work," is always a cause of much extra expense, while fragments of rock broken down with the ore vitiate its quality, if not picked out, and, if picked out, put a higher labor cost on the ore.

The local relations of a mine have an influence in affecting the

cost of mining its product. When it lies close to the surface, or has a considerable portion of its tonnage situated so that it can be readily removed by open pit mining, the inexpensiveness of that system helps to a greater profit on the ore produced. The pumping cost is also at a minimum; or natural drainage may be possible. Local conditions affecting the cost of the installation of the surface equipment, and in a greater or less degree the cost per ton of ore, climatic conditions, and quality of labor all affect cost of production.

The water to be handled from a mine is more often than not a constantly increasing expense. Its volume may not grow larger as mining work extends downward, but the increased lift of a smaller volume may more than counterbalance the expense of handling it. In a region where a limestone formation overlies an ore formation, one may expect increased volume of water as depth is gained; for limestone, because of its ready solubility, is the home of subterranean water courses of great length and magnitude. The caving due to the mining of ore bodies so located is likely to open up connections with the water-courses of the limestone, and this water, once tapped, is always on draught.

The timber supply necessarily is a larger item with a soft-ore mine, as its levels, winzes, ore chutes, drifts, and cross-cuts need artificial support. Some methods of mining soft ore involve the use of less timber than others, but with the least expensive the cost is, in the aggregate, a considerable sum.

From the foregoing it is seen that the determination of the value of an iron mine is a many-sided problem. It involves, among other things, questions of business, of mining, of engineering, of chemistry. Only intelligent and conscientious effort can estimate the value of the different factors with any degree of accuracy. The questions to be solved require a thoroughly reliable, capable man,—one who is up-to-date in mining practice. He should be thoroughly conversant with the market value of iron ores and familiar with their chemical qualities. He should have a clear conception of the ways in which economies, big and little, are obtained in mining,—a conception which has been disciplined by successful superintendence of an iron mine, as well as by the studies of its cost-sheets. He should have wrought over the problems of the opening of iron mines and the adaptation and installation of mine equipments. Only a man thus qualified can be expected to furnish a reliable estimate of the value of an iron mine, or of the cost of opening and equipping it.

These considerations have application, directly or indirectly, to iron mines wherever located. Judgments of iron mine values must be based on the underlying principles noted, which have universal application to this species of property.

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Am. Manufacturer and Iron World. *w.* $4. Pittsburg.
American Miller. *m.* $2. Chicago.
American Shipbuilder. *w.* $2. New York.
Am. Soc. of Irrigation Engineers. *qr.* $4. Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Archæologist, The. *m.* $1. Columbus, O.
Architect, The. *w.* 26*s.* London.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $6. New York.
Arena, The *m.*. $5. Boston.
Australian Mining Standard. *w.* 30*s.* Sydney.
Banker's Magazine. *m.* $5. New York.
Banker's Magazine. *m.* 18*s.* London.
Bankers Magazine of Australia. *m.* $3. Melbourne.
Board of Trade Journal. *m.* 6*s.* London.
Boston Journal of Commerce. *w.* $3. Boston.
Bradstreet's. *w.* $5. New York.
Brick. *m.* $1. Chicago.
Brick Builder, The *m.* $2.50. Boston.
British Architect, The. *w.* 23*s.* 8*d.* London.
Builder, The. *w.* 26*s.* London.
Bulletin Am. Geographical Soc. *q.* $5. New York.
Bulletin Am. Iron and Steel Asso. *w.* $4. Phila.
Bulletin of the Univ. of Wisconsin, Madison.
California Architect. *m.* $3. San Francisco.
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Review. *m.* $1.50. Ottawa.
Century Magazine. *m.* $4. New York.
Chautauquan, The *m.* $2. Meadville, Pa.
Clay Record. *s-m.* $1. Chicago.
Colliery Engineer. *m.* $2. Scranton, Pa.
Colliery Guardian. *w.* 27*s.* 6*d.* London.
Contemporary Review. *m.* $4.50. London.
Cosmopolitan, The *m.* $1.20. New York.
Domestic Engineering. *m.* $2. Chicago.
Electric Power. *m.* $2. New York.
Electric Railway Gazette. *w.* $3. New York.
Electrical Age. *w.* $3. New York.
Electrical Engineer. *w.* 19*s.* 6*d.* London.

Electrical Engineer. *w.* $3. New York
Electrical Engineering. *m.* $1. Chicago.
Electrical Industries. *m.* $1. Chicago.
Electrical Plant. *m.* 6*s.* London.
Electrical Review. *w.* 21*s.* 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24*s.* London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7*s.* 6*d.* London.
Engineer, The. *s-m.* $2.50. New York.
Engineer, The. *w.* 36*s.* London.
Engineer & Contractor. *w.* $1. San Francisco.
Engineers' Gazette. *m.* 8*s* London.
Engineering. *w.* 36*s.* London.
Engineering and Mining Journal. *w.* $5. N. Y.
Engineering Magazine. *m.* $3. New York.
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Engineering Review. *m.* 7*s.* London.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
Fairplay. *w.* 32*s.* 6*d.* London.
Fire and Water. *w.* $3. New York.
Forester, The. *bi-m.* 50 cts. May's Landing, N.J
Fortnightly Review. *m.* $4.50. London.
Forum, The. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4. New York.
Gas Engineers' Mag. *m.* 6*s.* 6*d.* Birmingham.
Gas World, The. *w.* 13*s.* London.
Geological Magazine, The. *m.* 18*s.* London.
Gunton's Magazine. *m.* $2. New York.
Heating and Ventilation. *m.* $1. New York.
Ill. Carpenter and Builder. *w.* 8*s.* 8*d.* London.
Improvement Bulletin. *w.* $5. Minneapolis.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Inventive Age. *s-m.* $1. Washington.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30*s.* 4*d.* London
Iron & Steel Trades' Journal. *w.* 25*s.* London
Iron Industries Gazette. *m.* $1.50. Buffalo.
Iron Trade Review. *w.* $3. Cleveland.
Journal Am. Chemical Soc. *m.* $5. Easton.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal of Electricity, The *m.* $1. San Francisco.
Journal Franklin Institute. *m.* $5. Phila.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6*s.* London
Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m.* $2. Chicago.
Locomotive Engineering. *m.* $2. New York.
Lord's Magazine. *m.* $1. Boston.
Machinery *m.* $1. New York.
Machinery. *m.* 9*s.* London.
Manufacturer and Builder. *m.* $1.50. New York.
Manufacturer's Record. *w.* $4. Baltimore.
Marine Engineer. *m.* 7*s.* 6*d.* London.
Master Steam Fitter. *m.* $1. Chicago.
McClure's Magazine. *m.* $1. New York.
Mechanical World. *w.* 8*s.* 8*d.* London.
Metal Worker. *w.* $2. New York.
Milling. *m.* $2. Chicago.
Mining. *m* $1. Spokane.
Mining and Sci. Press. *w.* $3. San Francisco.
Mining Industry and Review. *w.* $2. Denver
Mining Journal, The. *w.* £1. 8*s.* London.
Mining World, The. *w.* 21*s.* London.
National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50. London
North American Review. *m.* $5. New York.
Overland Monthly. *m.* $3. San Francisco.
Paving & Munic. Eng. *m.* $2. Indianapolis.
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6*s.* 6*d.* London.
Popular Science Monthly. *m.* $5. New York.
Power. *m.* $1. New York.
Practical Engineer. *w.* 10*s.* London.
Proceedings Engineer's Club. *q.* $2. Phila.
Progressive Age. *s-m.* $3. New York.
Progress of the World, The. *m.* $1. N. Y.
Railroad Car Journal. *m.* $1. New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7*s.* London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5*s.* London.
Review of Reviews. *m.* $2.50. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10*s.* London.
School of Mines Quarterly. $2. New York.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York.
Scientific Am. Supplement. *w.* $5. New York
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scientific Quarterly. *q.* $2. Golden, Col
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Am. Ins. Electrical Eng. *m.* $5. N. Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York.
Transport. *w.* £1. 5*s.* London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $4. Butte, Mon.
Western Railway Club, Pro. Chicago.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.

ARCHITECTURE & BUILDING

See also "Civil Engineering" and "Domestic Engineering."

The Avery Architectural Library.

No more notable or valuable memorial of an architectural nature has been erected in America than the library in Columbia College which Mr. and Mrs. Samuel P. Avery have founded in memory of their son, Henry Ogden Avery. To the architects of New York and its immediate vicinity this great collection of books must always be an adjunct to their studies; to the architects of the whole country it is of positive value to know that at one place, at least, there may be found almost every architectural book of importance, from those of small cost to the most expensive, and an abundance of illustrative material quite unequalled by any other American library.

The catalogue of the collection has just been published,—a sumptuous volume of nearly twelve hundred pages, printed in the finest manner and a veritable memorial in itself. Some thirteen thousand volumes are now in the collection, which is constantly being added to, the original gift of thirty thousand dollars having been supplemented by many subsequent gifts. The selection of books has been made on a liberal scale, and includes representatives of all the arts allied to architecture, making it, in effect, a real art library. The architect may find here many costly books whose price places them quite outside the reach of ordinary folk, and the student may find ample material for the study of every important phase of architectural history. Upwards of two hundred sets of periodicals are included, a feature quite unique among the art libraries of the country.

Henry Ogden Avery, in whose memory this library has been founded, was a young man of brilliant promise, whose professional career was interrupted, almost on its threshold, by his untimely death. Of strong artistic tastes, surrounded by an artistic atmosphere almost from his birth, he perhaps would have chosen for himself the literary and illustrative memorial established by his parents. Certainly none could have been of greater utility to the art students, and the generous founders of the library are entitled to the heartfelt gratitude of those who profit by their liberality. The bringing together of the books of this collection in the five years which have passed since the first gift was made has been a work of no small magnitude. The selection has been made by Mr. George H. Baker, librarian of the college, Prof. W. R. Ware, and Mr. Russell Sturgis. These three gentlemen form a commission, of whom the first two are always to be represented by their successors, with whom is lodged the choice of a successor to Mr. Sturgis, who must be an architect not connected with the college.

It is needless to add that in the accomplished hands of these gentlemen Mr. and Mrs. Avery have had their wishes carried out in the most careful and thorough manner. It is not an antiquarian collection, but a generously-conceived architectural library. It must materially add to the artistic supremacy of New York, should that distinction ever be disputed by other American towns.

Some German Buildings.

THE drawings published in the German architectural paper, *Architektonische Rundschau*, of Stuttgart, afford an interesting insight into a phase of current architecture we scarcely know in America. We have, it is true, many buildings which we rightly classify as German, not only from the fact that their architects are of German extraction, but because of that uncertain quality of art which we instinctively recognize as of that nationality. The illustrations of the *Rundschau*, of which five parts for the current year have appeared, are not, as a whole, notable. Like the English and American architectural papers, this periodical has to depend, to a certain extent, on what it can obtain. Its drawings, there-

fore, exhibit what may be termed ordinary buildings rather than important or notable ones. The villa reproduced herewith is, perhaps, better than the average. There is a sufficient sense of the picturesque in the general arrangement of the masses, but the design is hopelessly ruined by the coarseness of the detail, and the ugliness of the motifs. The gable, of which only a portion is seen in this drawing, is a thoroughly German feature, and its effect is greatly weakened by being supported on a column standing free on one corner. The stair windows on the side are hopelessly injured by the diagonal line at their base, which corresponds to no other feature. Another country-house embraces many more oddities, including a circular projection on one front capped by a rectangular and projecting headpiece in the roof. A church has a singular buttress-like feature of open arches at one side, with triple plain panels above the main door in the tower forming the chief feature of the front, which are cut off in an exceedingly naive manner above a circular window over the entrance porch.

It would be unfair to the best spirit of modern German architecture to take these pictures as illustrating the highest phase of German art; yet, as they appear in a leading German technical journal, it is impossible not to feel that we have at least types of average work, if no more. *The Builder*, of London, has recently published some large German buildings, one of which, the elevation of the new imperial courts of justice at Leipsic, was reproduced in these pages last month. This month it publishes the new National Bohemian Museum at Prague, and the Palace of the Prussian Diet, Berlin, of which the last is illustrated herewith. Other drawings have been published in the American papers. While it is a most excellent thing to learn what other nations are doing in architecture, it is not a little satisfactory to find that our own architects are doing so much better work, as a rule, than foreigners. We have not yet produced in this country masterpieces like the Paris Opéra or the Musée Galliera, which the French architects occasionally produce. But this is because we have no opportunities for such work rather than because of the inability of our architects to produce them.

The most distinguishing note of American architecture is its feeling for the picturesque, and very successfully do American architects interpret this delightful architectural quality. In the German designs there is much the same spirit, without any appreciable ability of interpretation. That is to say, the houses, where possible, are broken into masses, the roof lines are varied, and not a few picturesque devices introduced.

Illustrations of the Month.

THE *Inland Architect* for February prints the accepted and the second premiated designs for the library of the University of Wisconsin; the other designs in this competition were published in a previous number and commented upon in our January issue. The accepted design, by Messrs. Ferry & Clas, of Milwaukee, shows many changes as compared with the first design of the same architects. The pedimented portico, which is the feature of the main front, is lifted onto a basement, the original flight of steps being suppressed, — an arrangement certainly much more suited to the climate of Madison than that devised by the Greeks. The whole building, in fact, is now raised on a basement, the front broadened, the wings shortened, and the low dome brought forward and raised somewhat, so as to become an absolute feature of the façade. On the whole, the changes are for the better in every way. To treat the first story of a building as an architectural basement, as has been done in this instance, has the support of long-standing precedent, and is at the same time a perfectly legitimate device. Yet it may be questioned if there is not too great a tendency to build basements for the simple reason that they afford a means of lifting the structure up so that it can be seen. That the exterior treatment of a building logically begins with the emergence of its walls above the ground needs no argument; but is it absolutely necessary to build up one story before we can begin

to show off our columns and our pilasters, our windows and our niches? If there are precedents for basements, there are quite as many for buildings without them. A basement is often not only useful, but necessary; but we need not, on that account, insist on it in every considerable design.

The *American Architect* continues its illustrations of the interiors of the Metropolitan Club House in New York with three superb photographs (Feb. 8). These

"THE DUNSTER" DORMITORY, CAMBRIDGE, MASS., FOR J. A. LITTLE. LITTLE, BROWN & MOORE, ARCHITECTS. [AMERICAN ARCHITECT, FEBRUARY 8.]

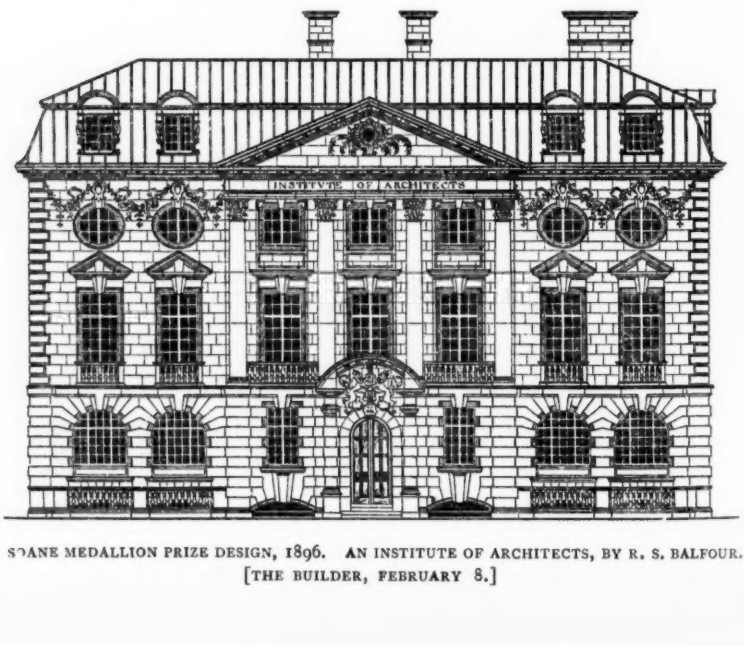
gorgeously-decorated rooms are in striking contrast to the views of the Sainte Claire Club House at San José, Cal., by Mr. A. Page Brown (Feb. 1), whose death in the same month was a serious loss to architecture on the Pacific slope. The latter design is charming and unpretentious, quite simple, and yet highly effective with its ample wall spaces and severe fenestration.

Two photographs and a plan illustrate the recently-completed city hall of Paterson, N. J., by Messrs. Carrère and Hastings. It is a fine design, carried out with that scholarly feeling which Mr. Hastings has taught us to look for in his work. The detail is less abundant than in many of his earlier buildings, and much strength is gained by relative simplicity. The design consists of a basement and two stories, treated with large Corinthian pilasters which support the entablature with which the building is crowned. In the center, boldly rising directly behind the balustrade of the roof, with which it is connected by a broken curved pediment at the base, is a square tower crowned with a small dome. It was, perhaps, a venturesome thing to design a tower rising in this way out of the roof, close to the front wall, yet not visible in it; but of the completeness of its success there can be no question. Not the least interesting feature is the fact that the main cornice is literally at the top of the building, and is thus

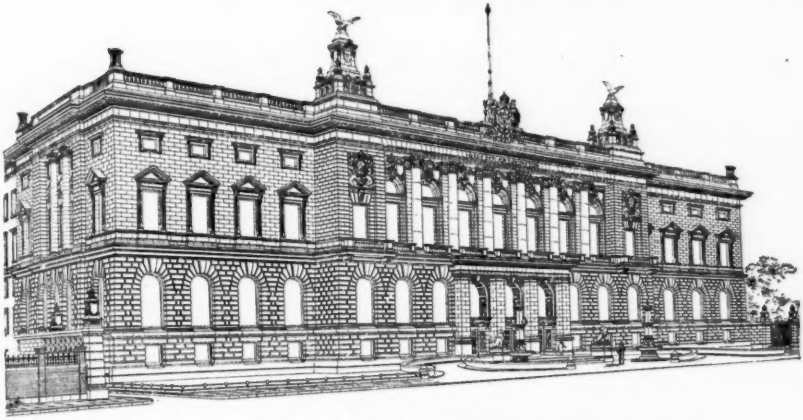
its natural crown and finish. Usually Mr. Hastings places his cornices part way down his façades, and has not escaped that habit in the tower of this building. This is easily one of the most notable buildings in New Jersey, and the lesser cities of that State, and of other States, will do well to study it and profit by its example.

The splendid art of the Paterson city hall rather casts in the shade some examples of municipal architecture published in the same journal. The accepted competitive design for city hall, station house, and jail at Cohoes, N. Y., excites wonder that it should have been necessary to go to Topeka for an architect,—and wonder also as to the nature of the other designs submitted for this competition, when the successful one is so commonplace. The Wayne county jail and sheriff's residence at Detroit is an unpretentious design, not nearly as formidable as the building of the Chicago Historical Society illustrated in the same journal. Of country-houses the most notable are a group of three for Bay Ridge, N. Y., including one for the architect by Mr. A. E. Parfitt. Several more pretentious designs are printed, but none of note. One of the largest is an example of that unnecessary copying of Colonial detail which passes, in many quarters, for so excellent art at this day. A design for a town hall at East Orange, N. J., is one of the many instances we see now-a-days of the use of classic columns as the leading *motif*. The same may be said of the Pope Monument in Boston,—a Doric portico of four columns irregularly spaced, and therefore quite wanting in that classic truth which its designers evidently imagined they were securing.

The photographic illustrations in *Architecture and Building* include the residence of W. V. Lawrence in New York, by the late R. M. Hunt. This may be profitably compared with the house for Mrs. Schmid by his son, published in an earlier number of the same paper. The general *motif* of the two designs is the same,—a circular turret on the avenue corner, with the entrance front on the cross street. The younger Hunt's design is richer than the elder's, on which it is frankly based. The Seton Hospital at Spuyten Duyvil, N. Y., is a simple, well-composed structure, with an enriched central pavilion to give it necessary relief and character. A mer-



SOANE MEDALLION PRIZE DESIGN, 1896. AN INSTITUTE OF ARCHITECTS, BY R. S. BALFOUR.
[THE BUILDER, FEBRUARY 8.]



PALACE OF THE PRUSSIAN DIET, BERLIN. FRIEDERICH SCHULZE, ARCHITECT.
[THE BUILDER, FEBRUARY 22.]

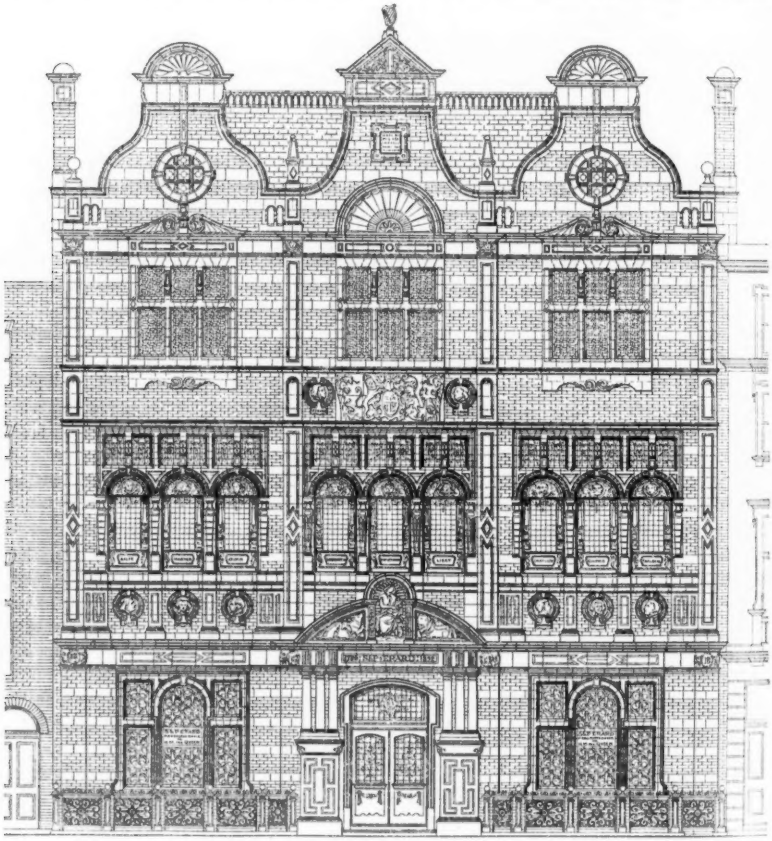
cantile building at Fourth and Greene streets, New York, is a type of the commercial buildings in that locality, many of which are built by architects of German extraction. It is a piled-up design, with many features in the different stories, and yet without any especially marked anachronisms. The most important public building illustrated in this journal is the State Library and Executive building at Harrisburg, Pennsylvania,—a two-story structure, of which the first floor is plainly treated as a basement, and the upper with ornamental windows and porticoes in the main pavilions. It is a design quite lacking in dignity, owing to the many breaks in the façades, and, so far as the photograph shows, lacking as well in refinement.

The most notable illustrations in *The Builder* are of German buildings. One, the palace of the Prussian Diet, is reproduced herewith. The leading *motifs* are obviously borrowed from the Italian Renaissance, but the architect has shown himself incapable of throwing off the traditional German influence. Much more marked in German feeling is the building of the National Bohemian Museum at Prague. A portico with long colonnades on either side forms the chief feature of the façade, a high square lantern or tower with four-sided dome marking the main entrance, and four smaller domes the corner pavilions. This journal also publishes a fine design for a summer cottage by Mr. Ashton Webb, a well composed house in domestic Gothic that is quite as elaborate as some American country-houses. A suburban residence by Mr. A. M. Poynter is most unnecessarily bald and simple. As an example of the work done by English architectural students, some interest attaches to the Soane medallion prize design for an Institute of Architects, a thoroughly English classic design, as far removed from the "classic" studies of American students as it is possible for any type of classic architecture to be. In this country we fashion our classic structures after the French mode; the English have at least a type of their own that justifies such studies as this. Much more valuable, and a type of work we cannot have in this country, because we have no historical monuments, is a measured elevation of the Horse Guards in London, also published in the *British Architect*. The business block in Great M rlborough street, London, reproduced in these pages, is interesting as a style of building much affected by contemporary English architects. That this design suffers from overelaboration of parts goes without saying, but it is valuable in showing the exceedingly clever manner in which many Eng-

lish architects combine vertical and horizontal lines in their design. Here both of these elements are distinctly marked, yet the result, as a whole, is entirely homogeneous and complete. American architects have not yet learned to use both these elements in a single design with the success which the British architects have achieved. Either one or the other predominates in American designs, or, if both are freely used, the result is a series of features built one on top of the other, instead of the unity which the English architects attain.

The Architect is performing good service in printing large photographs of important English buildings,—a work no other English architectural journal undertakes. As a rule they are well printed, and of sufficient sizes to bring out the detail sufficiently. A dining-room restored by Messrs. Ernest George and Peto is among the illustrations of the month.

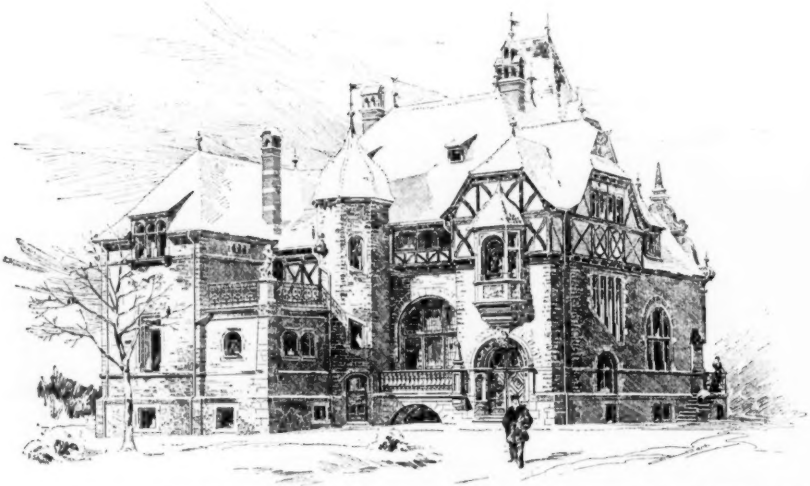
The Brickbuilder publishes two elevations, a section and a sheet of plans of St Luke's Hospital in New York. From the text, which is not critical, we learn that the disposition of the space in floor-plans has been admirably disposed. This statement is hardly supported by the plans themselves, the pavilions being grouped together in a crowded fashion. Only a



A BUSINESS BLOCK IN LONDON. REMODELED BY P. G. STONE, ARCHITECT.
[THE BUILDER, FEBRUARY 15.]

BOWERY ELEVATION OF THE BOWERY BANK BUILDING. NEW YORK. McKIM, MEAD & WHITE, ARCHITECTS. [ARCHITECTURAL REVIEW, JANUARY.]

portion of the buildings have been erected as yet, and the very considerable amount of air and sunlight which the pavilions receive is no criterion of the condition of the building when finally completed. As a design, the façade is sufficiently dignified and supplied with enough in the way of architectural adornments to make it a notable addition to the great buildings of the metropolis. Ornamental qualities,



VILLA MENZER IN NECKARGEMUND. L. SCHAFER, ARCHITECT. [ARCHITEKTONISCHE RUNDSCHAU.]

however, do not make a hospital successful.

The Architectural Review, in its first number of the year, prints detail drawings of the Bowery Savings Bank, one of which is reproduced in these pages, and an elaborate series of drawings of the new public library at Fall River, Mass. Of the former it need only be said that it is quiet and refined and well-studied; which, being translated into the vernacular, means that it is commonplace. And that its commonplaceness is unobtrusive and good of its kind is the best that can be said for it. Of the Fall River library the *Review* itself obligingly furnishes the criticism. "It is," it says, "very good in some respects and disappointing in others. The different motives which compose the façade are much out of scale with each other. The general conception is of a simple, dignified building. The entrance and entire treatment upon the axis is out of accord with the conception, and has too many and too small parts." And so on, and so on. The manner in which praise and condemnation alternate in these remarks is very interesting. But this is a genuine specimen of Bostonese architectural writing.

THE ENGINEERING INDEX—1896.

Current Illustrations and Leading Articles on Architecture and Building in the American and English Architectural and Engineering Journals—See Introductory.

Index to Illustrations.

BATH.—For Southern Improvement Co., Warm Springs, Va., by C. H. Read, Jr., Amer. Archt., Feb. 15.

CHURCHES.—Chapel House of Retreat, Sisters of Bethany, Clerkenwell, Eng. (3), by E. Newton, Brit. Archt., Jan. 31. Proposed west front, Manchester cathedral, ibid., Jan. 24.—SS. Michael and All Angels, Colehill, Wimborne, Eng. (view, interior, altar detail, and plan), by W. D. Carröe, Builder, Feb. 15.—Trinity Congregational Church, North Attleboro, Mass., by Stephenson and Greene, Archt. and Build., Feb. 8.—Methodist Episcopal Church, Springfield, Mass., by F. R. Comstock, ibid., Feb. 29.—Church of S. Columba, Maryland Point, E. London, by E. P. Warren, Amer. Archt., Feb. 1.—St. Peter's, Eaton Square, London (interior), restored by A. W. Bloomfield, ibid., Feb. 22.—Forty-Third Street M. E. Church, Philadelphia, by Jacoby and Weishampel, ibid., Feb. 29.—Chapel, Rhododendron Estate, near Biltmore, N. C. (elevation and plan), by R. Gustavino, ibid.

CLUBS.—Ste. Claire Club House, San José, Cal. (with 2 interiors), by A. P. Brown, Amer. Archt., Feb. 1.—Metropolitan Club, New York (three interiors), by McKim, Mead and White, ibid., Feb. 8.—Club House, Century Wheelmen, Philadelphia, by R. C. Loos, Archt. and Build., Feb. 29.

We supply copies of these articles. See introductory.

COMMERCIAL BUILDINGS.—For S. and P. Erard, London, by P. G. Stone, Builder, Feb. 15. —For British Columbia Land and Investment Agency, Vancouver, B. C., by R. M. Fripp, Can. Archt., Feb. —Phoenix Building, Springfield, Mass., by E. A. Ellsworth, Archt. and Build., Feb. 1.—Mercantile Building. Fourth and Greene streets, New York, by Cleverdon and Putzel, ibid., Feb. 15.—Bowery Bank, New York (detail and elevation), by McKim, Mead and White, Archt. Rev., Jan.—Phoenix Building, Springfield, Mass., by E. A. Ellsworth, Amer. Archt., Feb. 1.—For A. N. Mayo, Springfield, Mass., by Gardner, Pyne and Gardner, ibid. —For E. Fletcher and Co., Birmingham, Eng., by E. Nicol and Goodman, ibid., Feb. 15.—Central Exchange Building, Worcester, Mass , by W. G. Preston, ibid.—Passenger Station, Baltimore and Harrisburg Railroad, York, Pa., ibid., Feb. 22 —Arcade Building for Dickson and Talbott, Indianapolis (with plan and interior), by Vonnegut and Bohn, In. Archt., Feb.

HISTORICAL.—The Horse Guards, Whitehall, Eng. (measured elevation and plan), Builder, Feb. 22, Brit. Archt., Jan. 24.—Theatre of S. Carlos, Naples (measured elevation), by J. S. Stewart, ibid., Feb. 7.—Alcazar, Toledo (measured elevation and plan), by same, ibid.—Illustrations of Spanish War Harness, Fifteenth Century, ibid.—Burgos Cathedral (interior) Builder, Jan. 25. —Cathedral, Soissons, France (interior north transept), ibid., Feb. 8. —Illustrations to Lectures on Romanesque Architecture, by G. Aitchison, ibid., Feb. 8, Feb. 15, 22.—Dunblane Cathedral, N. B., restored by R. Anderson (two interiors), Archt., Jan. 31; exterior, ibid., Feb. 14.—Banqueting Hall, Kensington Palace (measured elevation and plan), ibid. —Château, Fontaine-le-Henri, Caen, France (view), ibid., Feb. 7, Feb. 14. —House in Place de la Pucelle, Rouen, France, ibid., Feb. 21.—Schlosskirche, Wittenberg, Saxony (interior), Amer. Archt., Feb. 1.—Hotel d'Alluye, Blois, France, ibid.—Port Cochère, Versailles, France, ibid., Feb. 22. —Porta Pallio, Verona, Italy, ibid. —Figure of Christ, Cathedral of Reims, France, ibid.—Wells, Nancy, France, Sixteenth Century, ibid., Feb. 29. —Italian Lavabo, Fifteenth Century, South Kensington, ibid. —College of Santa Cruz, Toledo (entrance), Archt. and Builder, Feb. 29.

HOSPITALS.—St. Luke's Hospital, New York (elevation, section and plans), by E. Flagg, Brick., Feb.—Seyton Hospital, Spuyten Duyvil, N. Y., Shickel and Ditmars, Archt. and Build., Feb. 1.—Heath Convalescent Home, Llanfairfechan, North Wales (2), by T. Bower, Archt., Feb. 14.

HOTELS.—Halcyon Inn, Little Tupper Lake, Adirondack Mountains, by F. M. Comstock, Archt. and Build., Feb. 29.

HOUSES, CITY.—For W. V. Brokaw and Mrs. B. Gilbert, Fifth avenue, New York, by H. F. Kilburn, Archt. and Build., Feb. 8.—Row, East 76th street, New York, by A. M. Welch, ibid., Feb. 15.—For G. W. Shiebler, Brooklyn, N. Y., by F. Freeman, ibid., Feb. 22.—On West 80th street, New York, by A. M. Welch, ibid.—At Buffalo, N. Y., by E. G. W. Deitrich, ibid.—For W. V. Lawrence, 78th street and Fifth avenue, New York, by R. M. Hunt, ibid., Feb. 29.—Block of Basement Houses, by J. B. Lord, Amer. Archt., Feb. 1.—For R. McK. Jones, St. Louis, by Eames and Young, ibid., Feb. 15.—For G. B. Carpenter, Chicago, by Treat and Foltz, ibid., Feb. 22. —For H. C. Chivers, Architect, St. Louis, In. Archt., Feb.—For J. C. Roberts, St. Louis, by J. B. Long and Co., ibid.—For E. H. Terrell, San Antonio, Tex., by A. Giles and Guindon, ibid.—For Dr. G. H. Bartlett, Buffalo, by W. W. Johnson, ibid.—For B. S. Thompson, Detroit, by Mason & Rice, ibid.—For Mr. Long, Detroit, by Rogers & McFarlane, ibid.—For E. A. Osburn, by J. Scott & Co., ibid.—For A. B. Towers, Chicago, by G. W. Maher, ibid.—For Emmons Blaine, Chicago, by Shepley, Rutan and Coolidge, ibid.

HOUSES, COUNTRY.—At Haslemere, Eng., by E. Newton, Brit. Archt., Jan. 31.—For A. B. McKechnie, Milliken Park, Renfrewshire, N. B., (two views and plan), by C. Davidson, ibid., Feb. 21.—Frensham Hall, Haslemere, Eng., by Beazley and Burrows, Builder, Jan. 25 —At Knutsford, Cheshire, Eng., by J. Brooke, ibid.—In Isle of Wight, by A. Webb, ibid.—Mansion, Folkestone, Eng., by G. H. Gordon, ibid., Feb. 1.—Design for a Suburban House (with plan), by A. M. Poynter, ibid., Feb. 22.—For W. H. P. Acton, Ont., by J. A. Ellis, Can. Archt., Jan.—For W. E. Vyse, Babylon, N. Y., by C. K. Birdsall, Archt. and Build., Feb. 8.—Cottage, Bayshore, N. Y., by same, ibid.—For W. Shiffer, Arverne, N. Y., by Parfitt Bros., ibid., Feb. 15.—For J. S. Stearns, Madison, N. J., by Stephenson and Greene, ibid., Feb. 22.—For M. A. Collins, Germantown, Phila., by C. H. Kirk, ibid.—At Bay Ridge, N. Y., by A. E. Parfitt, Amer. Archt., Feb. 8.—At Chicopee Falls, Mass., by G. Kirkham, ibid.—For A. W. Pope, Wellesley, Mass., by H. M. Stephenson, ibid.—Another, by same, ibid. —For Harriman Bros., Annisquan, Mass., by D. H. Woodbury, ibid., Feb. 22.—For M. K. Green, Jamaica Plain, Mass. (2), by Rand & Taylor, Kendall & Stevens, ibid.—For C. B. Appleton, Brookline, Mass. (with plan and interior), rebuilt by Kingsbury and Richardson, ibid., Feb. 29.—For J. MacMeans, North Edgewater, Chicago, by G. W. Maher, In. Archt., Feb.—For J. C. Scales, Buena Park, Chicago, by same, ibid.

INTERIORS.—Three Studies for Hall, by W. T. Barlow, Builder, Feb. 1. —S. Michael and All Angels, Colehill, Wimborne, Eng. (view, altar and pulpit details), by W. D. Carcöe, ibid., Feb. 15.—Arcade Building for Dickson and Talbott, Indianapolis, by Vonnegut & Bohn, In. Archt., Feb.—Dunblane Cathedral, N. B. (pulpit and organ details), Archt., Jan. 31.—Dining Room, West Dean Park, Singleton, near Chichester, ibid., Feb. 21. —Ste. Claire Club-House, San José, Cal. (parlor and entrance hall), by A. P. Brown, Amer. Archt., Feb. 1.—Residence, Lord Leighton, London (corridor), by G. Aitchison, ibid.—Metropolitan Club, New York (dining room, ladies' dining room, billiard room, and mantel detail), by McKim, Mead and White, ibid., Feb. 8.—Residence, Lord Leighton, London (Arab Hall), by G. Aitchison, ibid. (picture room), by same, ibid., Feb. 15. —For M. K.

Green, Jamaica Plain, Mass. (hall), by Rand & Taylor, Kendall & Stevens, ibid., Feb. 22.—St. Peter's, London (chancel), by A. W. Bloomfield, ibid.—For C. B. Appleton, Brookline, Mass., by Kingsbury & Richardson, ibid., Feb. 29.—Staircase, Gosford House, England, by W. Young, ibid.—University of Wisconsin, Madison (reading room, accepted design), by Ferry & Clas (reading room and rotunda, second premium design), by Van Brunt & Howe, In. Archt., Feb.

LIBRARIES.—Public Library, South Audley street, London, by A. J. Bolton, Archt., Feb. 7.—Technical Institute and Public Library, West Ham, Eng., competitive design for, by Newman and Newman, ibid.—Libra y University of Wisconsin, Madison (design in first competition, also accepted design with plan and interior), by Ferry and Clas, In. Archt., Feb.—The same (second premium design with plan elevation and interior), by Van Brunt and Howe, ibid.—South Orange, N. J., Free Circulating Library (2), by DeW. Clinton, Jr., and W. M. MacCafferty, Archt. and Build., Feb. 1.—State Library and Executive Building, Harrisburg, Pa., by J. T. Windrim, ibid., Feb. 15.—Public Library, Fall River, Mass. (elevation, section and plan), by Cram, Wentworth and Goodhue, Archt. Rev., Jan.—For Newton Theological Seminary, Newton Centre, Mass., by Rand & Taylor, Kendall & Stevens, Amer. Archt., Feb. 22.—Proposed "Fiske Memorial Library," Boston, Mass., by D. H. Woodbury, ibid., Feb. 29.

MONUMENTS.—Emile Augier, Place de l'Odéon, Paris, by M. E. Barrias, Builder, Feb. 1.—Messonier, "Jardin de l'Infante," Louvre, Amer. Archt., Feb. 1.—Pope Tomb, West Hills Cemetery, Boston, by Dwight and Chandler, ibid.—To the Conception, Naples, ibid., Feb. 29.—Argyll Monument, S. Giles' Cathedral, Edinburgh, by Sydney, Mitchell and Wilson, Archt., Feb. 21.

MUNICIPAL BUILDINGS.—Chief Constable's House, Stafford, Eng. (2), by H. T. Hare, Brit. Archt., Jan. 24.—Town Hall, East Orange, N. J., by J. D. Matthews, Amer. Archt., Feb. 1.—City Hall, Cohoes, N. Y., Holland and Co., ibid.—City Hall, Paterson, N. J. (2), by Carrère and Hastings, ibid, Feb. 15.—County Jail and Sheriff's Residence, Detroit, Mich., by J. Scott and Co., ibid, Feb. 22.—New Record Offices, London, by J. Taylor, ibid.—Town Hall, Clerkenwell, Eng. (with detail of door), by C. E. Vaughan, ibid, Feb. 29.

MUSEUMS.—National Bohemian Museum, Prague (with plans), J. Schulz, Builder, Feb. 1.—Proposed Building for Archaeological Society, by E. Boué, Amer. Archt., Feb. 15.—Chicago Historical Society, Chicago (2), by H. I. Cobb, ibid.

PUBLIC BUILDINGS.—State Library and Executive Building, Harrisburg, Pa., by J. T. Windrim, Archt. and Build., Feb. 15.—Palace of the Prussian Diet, Berlin (with plan), by F. Schulze, Builder, Feb. 22.

SCHOOLS.—St. John's Seminary, Wonerish, Surrey, Eng., by F. A. Walters, Builder, Jan. 25.—Competitive designs for Technical Institute and Public Library, West Ham, Eng., Archt., Feb. 7.—Barnes Medical College, St. Louis, by J. B. Legg and Co, Archt. and Build., Feb. 22.—Dunster Dormitory, Cambridge, Mass., for J. A. Little, by Little, Brown and Moore, Amer. Archt., Feb. 8.

STUDENTS' WORK.—Drawings of Theatre of S. Carlos, Naples and Alcazar, Toledo, by J. S. Stewart, Brit. Archt., Feb. 7.—Design for Country Bank, by T. G. Lucas, ibid, Feb. 14.—Country House and Garden, by R. S. Balfour, ibid, Feb. 21.—Saone Medallion design for an Institute for Architects, by R. S. Balfour, Builder, Feb. 8.—Design for Jewelry Store, by E. H. Russell, Can. Archt., Jan.—Design for Lodge, by W. P. Over, ibid.—Design for Lodge, by C. D. V. Hunt, Archt. and Build., Feb. 8.

Leading Articles.

***4080. The Architecture of Modern Bank Buildings. Ill. R. W. Gibson (Explaining the requirements of different types of banks in the matter of interior space arrangement, and the methods of meeting these). Eng Mag-March. 3500 w.**

4172. Classic Architecture. Henry Van Brunt (From the point of view of an architect. A discourse before Johns Hopkins University). Sci Am Sup-Feb. 15. 4400 w.

4190.—75 cts. From Liverpool to London. Wilson Eyre, Jr. (An account of a sketching trip for architectural study. Illustrated description mostly of domestic work). Arch Rev-Vol. IV. No. 1. 1200 w.

4195. Every-Day Italy. Claude Fayette Bragdon (Illustrated description of travels for architectural study. The first part gives an account of Turin, Genoa, and Siena). Am Arch-Feb. 15. Serial. 1st part. 4400 w.

***4268. Evolution of Design (Editorial comment on the tendency to take an evolutionary view of everything, and its application to the study of design in architecture, with reference and remarks concerning a late book by Alfred C. Haddon). Builder-Feb. 8. 2800 w.**

***4269. Romanesque Architecture (The first Royal Acad. lecture on architecture by Prof. Aitchison. The object of these lectures is to advance and improve architecture). Builder-Feb. 7. 7000 w.**

***4294. Service Reservoir at Buenos Ayres (Illustrated description of this handsome feature of the city. The style of architecture is French Renaissance, with terra-cotta decorations). Engng-Feb. 7. 700 w.**

4368. Doorways of the Cathedral of Mayence. A. B. Bibb (An illustrated historical outline in the main translated from "*The Cathedral of Mainz*," by Herm Emden, with notes by the translator). Am Arch-Feb. 22. 1500 w.

4369 The Use of the Grotesque in Sacred Architecture. Rev. Frank Sewall (A "sermon in stones" The sacred meaning that enters into the features of the building in the construction of churches). Am Arch-Feb. 22. 2200 w.

***4371. The Making of Architecture. George**

Aitchison (Extracts from a lecture delivered at the Royal Academy). Brit Arch-Feb. 14. 3000 w.

*4372. Florentine Villas. Lee Bacon (An interesting illustrated description of these villas, written in popular style). Scrib Mag-March, 7000 w.

4395. Fire Department Headquarters, Boston, Mass. (Illustrated description of a new fire department building in Boston, Mass). Eng Rec-Feb. 22. 2000 w.

*4407. Romanesque Architecture. Prof. Aitchison (The Second Royal Academy lecture on architecture this session). Builder-Feb. 15. 4000 w.

4439 The Olympion at Vienna (A brief description of an important building, to cost over $500,000, designed for the study of musical art, and the practice of many sports and pleasures, serving at the same time as a home for about eighty clubs, and a place where entertainments and festivals of all kinds can be held). Sci Am Sup-Feb. 29. 900 w.

*4461. High Buildings. C. H. Blackall (A defense of tall buildings by one who believes in them). Br Build-Feb. 3500 w.

4485. The Beginnings of Gothic Architecture (Illustrated description and historical account of the earliest Gothic construction). Arch & Build-Feb. 29. Serial. 1st part. 3000 w.

4486. Archaeological Remains in Arizona (Interesting reports, from the *N. Y. Sun*, regarding the discovery of relics of the cave-dwellers and cliff dwellers). Arch & Build-Feb. 29. 1000 w.

*4487. The Avery Memorial Library. Barr Ferree (A brief account of the architectural library connected with Columbia College, endowed in memory of Henry Ogden Avery. It is a general reference library, designed for the advanced student and the architect). Jour Roy Inst of Brit Arch-Jan. 23. 1800 w.

*4488. Westmoreland Slates: Their Geology, Chemistry, and Architectural Value. J. J. Thomas (The magnitude of the industry; its importance; its geological position; chemical composition; method of preparing, etc). Jour Roy Inst of Brit Arch-Jan. 23. 5800 w.

†4489 Wood-Carving and Wood-Carvers. W. H. Romaine-Walker, W. Aumonier, J. E. Knox, and W. S. Frith (Four interesting scholarly addresses, finely illustrated, on the above subject). Jour Roy Inst of Brit Arch-Feb. 6. 11000 w.

†4490. American Architecture and Architects, with Special Reference to the Works of the Late Richard Morris Hunt and Henry Hobson Richardson. John B. Gass (An interesting paper, tracing the growth of this art from the earliest American development. The influences that have shaped it, and the accomplished men that have aided its progress are also considered). Jour Roy Inst of Brit Arch-Feb. 6. 3800 w.

4496. Hollow Building Blocks. Ed. F. Darnell (The author recommends hollow blocks throughout the building, outside walls included and gives an example. Compression tests are also given). Clay Rec-Feb. 26. 2700 w.

*4543. Saint-Front de Périgueux and the Domed Churches of Périgord and La Charente. R. Phené Spiers (Abstract of paper read before the Roy. Inst. of Brit. Arch). Arch, Lond-Feb. 21. 900 w.

*4544. Architectural Training. G. A. T. Middleton (Paper read at the meeting of the Soc. of Archs., London). Arch, Lond-Feb. 21. 4200 w.

*4589. The Conditions of Building Contracts. A. A. Hudson (Paper read before the Surveyors' Institution. The conditions to be considered are carefully discussed). Builder-Feb. 22. 3000 w.

*4622. The Tall Office Building Artistically Considered. Louis H. Sullivan (An examination of the elements, confining the attention to those conditions that, in the main, are constant in all tall office buildings). Lippincott's Mag-March. 3500 w.

4652. High Office Buildings in New York. Ill. (Brief comments on legislation regarding high buildings, with some reference to appearance, etc). Sci Am Sup-March 7. 1000 w.

4659. A Large Truss in the Waldorf Hotel Extension, New York City (An interesting piece of structural work in the shape of a great truss carrying a floor so as to leave a room free from columns. Illustrations, with description of the special methods required for the work). Eng News-March 5. 1400 w.

4669. Shrinkage of Wood (Selection from Timber Bulletin No. 10, Agricultural Dept., Division of Forestry. Illustrated). Arch & Build-March 7. 2500 w.

*4708. Released Ashlar—A Problem in Ornamentation and Building Construction Ill. John Cotter Pelton (The paper is intended to call attention to the subject of released ashlar construction in its broad application to modern structures. The idea in the perfection of this method of construction is the minimum use of the more costly and beautiful materials, stone and marble). Jour Assn of Engng Soc-Jan. 6000 w.

*4719. The Future of American Architecture. John Stewardson (Extracts from a paper published in Lippincott's Mag). Brit Arch-Feb. 28. 2400 w.

*4720. Romanesque Architecture. Ill. Prof. Aitchison (The Fourth Royal Acad. lecture on architecture). Builder-Feb. 29. 3000 w.

*4721. The Modern Stencil and Its Application to Interior Decoration. Arthur Silver (Read at meeting of the Architectural Assn. A paper dealing with the subject fully). Arch, Lond-Feb. 28. 8000 w.

†4724. Architecture of Norway and Sweden. George W. Maher (Historical description). In Arch-Feb. 2500 w.

*4725. Cottage Design. Ill. Arthur M. Reed (A few of the qualities desirable to obtain are set forth for cottages in town, village and country, with general remarks). Ill Car & Build-Feb. 28. 4800 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

Influence of Magnesia in Cement.

THIS question has been one which has raised much discussion and the expression of varied opinions. The report of the committee of the German Portland cement manufacturers, reprinted in *The Scientific American Supplement* (Dec. 21), throws some light upon the subject, and we quote as follows from it:

"The majority of the committee, Dr. Schott, Herr Meyer, and Dr. Arendt, reported as follows: 'Our investigations, in part extending over a period of five years, have failed to show an injurious effect from magnesia in Portland cement, in the composition of which the magnesia replaces an equivalent amount of lime.'

"Dykerhoff, another member of the committee, could not agree with this view, his experiments having led him to a very different conclusion, a statement of which was given in a minority report, the substance of which is given below.

"Dr. Meyer described at length the experiments which led the majority of the committee to the conclusion that magnesia is a harmless ingredient in Portland cement. According to Dr. Meyer, this is always the case if the relation between the proportions of lime and magnesia, on the one hand, and silica, alumina, and iron oxid, on the other, remain normal. So long as the ratio of silica plus alumina plus iron oxid to lime plus magnesia does not exceed 2.2, the presence of magnesia up to 8 or 10 per cent. caused no harmful expansion, or cracking in the cement, even after several years. Further, any considerable percentage of magnesia in the raw material makes it extremely fusible and very difficult to burn properly without melting to a glass. For this reason cements containing much magnesia are practically shut out from consideration, owing to the impossibility of their passing the standard requirements as to tensile strength. It was therefore recommended that the resolution of the committee be adopted, and that thus a number of manufacturers should be relieved from the unjust requirement that the amount of magnesia contained in Portland cement should not exceed 3½ per cent. It, however, failed in being adopted.

"Herr R. Dykerhoff then gave an account of his own experiments on this question. In these experiments the proportion of lime was purposely kept low, the ratio $SiO_2 \times Al_2O_3 \times Fe_2O_3 : CaO$ being 1.83. Two series of mixtures were made; in the first, magnesia was added to the mixture in various proportions up to 21 per cent.: in the second, the same amounts of magnesia were substituted for equal amounts of lime. The charges were burned to complete sintering, and all over or under burned portions were rejected. The resulting cements were tested for tensile strength with three parts sand, and for expansion, at intervals up to five years. Complete tables showing the results in detail, are given. These results may be briefly described as follows:

"1st. Magnesia added. Tensile strengths at four weeks about equal up to 18 per cent. magnesia. All showed good increase in strength up to six months, after which time the cements with 17 and 21 per cent. magnesia showed decided falling off in strength. After two years all cements with over 4 per cent. magnesia showed a decrease in strength. At the end of five years the cements with 1 to 4 per cent. magnesia showed good strength, while those with 5 to 11 per cent. were weaker, and those with 17 and 21 per cent. magnesia showed a strength of 0. One cement with 6 per cent., lightly burned and not sintered, showed no noticeable decrease in strength in five years. Tests of expansion showed that in cements with 1 to 3 per cent. magnesia the expansion was slight up to one year, then practically ceased. With 4 per cent. and over the ex-

pansion during the later periods steadily increased with increased proportions of magnesia. Actual cracking was shown by the cement with 8 per cent. magnesia at the end of five years. Cements higher in magnesia all showed cracking at earlier periods.

"2d. Magnesia substituted for lime. Two mixtures were made, with 6 and 11 per cent. magnesia. Both showed decided falling off in strength after six months, and both showed cracking at five years and three years respectively. Another cement, containing 18 per cent. magnesia, was lightly burned and not sintered, and showed steadily increasing strength and freedom from cracking up to five years.

From these experiments Dykerhoff concludes that the harmful effect of magnesia in Portland cement is due to the dense condition which it assumes at the sintering temperature, in consequence of which the magnesia becomes hydrated only very slowly, and during hydration shows marked expansion. In light burned cements, on the other hand, like the American natural rock cements, the magnesia is in a far less dense condition, and readily becomes hydrated without injurious expansion. This view was confirmed by the addition of strongly sintered magnesia, separately prepared, to a cement nearly free from magnesia. With 10 per cent. sintered magnesia the strength was 0, and cracking appeared after two years. With 20 per cent. the cement disintegrated in four weeks. Light burned magnesia (magnesia usta) added in the same proportions produced no injurious effect. Dykerhoff summarizes his conclusions as follows:

"'The presence of magnesia up to 3 per cent. in Portland cement produces no change in its properties. From 4 per cent. on, however, magnesia, if sintered, whether added or substituted for part of the lime, has an injurious effect, producing increased expansion and decreased strength after long periods. This injurious effect is the stronger, the higher the percentage of magnesia. If the cement is not sintered, however, a high proportion of magnesia, even 18 per cent., may be harmless.'

"To make matters somewhat easier for manufacturers using magnesian material, he recommended that the allowable limit of magnesia be placed at 5 per cent. instead of 3½ per cent."

Strength of Arches.

ANOTHER valuable contribution to engineering data comes to us through *Engineering* (London, Feb. 21), from which we extract the following:

"An extremely valuable and interesting series of experiments have been carried out by the Austrian Association of Engineers and Architects on model arches. A sum upwards of £4,000 was expended, though the work was to a large extent done gratuitously." Experiments were made on arches of 4.42 ft., 8.85 ft., 32 ft. 9.7 in., 74.5 ft. and a steel girder of 5.9 ft. span. The results of experiments on arches of 8.85 ft., span are given in the accompanying table. The load was distributed over one half the span only.

"In no case was the deflection proportional to the load, though in the case of 6 it was nearly so. In all these cases the abutments consisted of I-beams efficiently tied together. Some experiments were next made on a concrete arch of 13.3 ft. span, 16.1 in. rise, and 3.94 in. thick at the crown. This arch sprang from regular skewbacks, and failed when a load of 790 lbs. per square foot was distributed over one half the span from abutment to crown. The deflection of the crown at rupture was about ¼ in., but a point midway between springing and crown had deflected ⅝ in. before failure occurred. A Monier arch of similar dimensions, tested in the same manner, failed under a load of 872 lbs. per square foot, but both arches showed cracks at the same load,—*viz.*, 614 lbs. per square foot. The deflection of the Monier arch at the crown when failure occurred was ¾ in., and at a point half-way between abutment and crown $\frac{7}{16}$ in. A Melan arch was next tried. In this construction steel arch ribs of I-section are imbedded in the concrete, being spaced in the present instance 3 ft. 4 in. apart. The I-beams in question were 3.15 in. deep, and the concrete filling was of the same thickness, being flush with

their upper and lower flanges. The span was 13.1 ft., and the rise 11.4 in. The arch was loaded on one side only, and failed when 3,370 lbs. per square foot was reached, breaking in three pieces under this load. The first cracks were observed under a load of 3,120 lbs. per square foot on the loaded side."

between the same abutments, the material being rammed concrete. The thickness of the arch ring was, however, uniform, being 2.3 ft. The body of the arch consisted of 1 part Portland cement, 2 parts broken stone, 3 parts gravel, and 3 of sand, but for the intrados and extrados a higher quality of concrete was used, that

TABLE SHOWING RESULTS OF EXPERIMENTS ON ARCHES

Number.	Material.	Span.	Thickness at Crown.	Rise.	Weight of Arch per Sq. Ft.	Breaking Load, Pounds per Sq. Ft. on Half Span.	Vertical Deflection at Crown under Load.	
							At Rupture.	Of 400 lbs per Sq. Ft.
		ft.	in	in.	lb.	lb.	in.	in.
1	Rammed concrete.....	8.85	3.35	9.05	286	1127	.94	.34
2	Ring of cement reinforced with wire netting (Monier's system)	....	1.95	10.23	230	1217	1.01	.34
3	Ring of cement (Monier's system) levelled up over the haunches with concrete. ..	....	2.17	10.23	505	1320	1.22	.18
4	Arch of ordinary bricks	....	5.51	9.84	248	883	1.87	.77
5	" Hönel bricks..	....	3.94	5.31	166	491	1.53	1.45
6	" corrugated iron.....	....	....	9.84	14	973	1.06	.45
7	" " " with L iron riveted along it at the springing..... .. .	....	...	....	20	1100	1 14	.47

The tests made on five 74.5 ft.-span arches, having a rise of about one fifth, loaded to destruction, are very important.

"Each arch was 6.65 ft. wide. A platform supported on six sets of columns, the feet of which rested directly on the extrados of the arch, extended in each case from one abutment to the crown, and the testing was effected by piling rails on this platform. The first experiments were made upon an arch of cut stone, and on one of brick. The stone used was a fairly hard limestone of excellent quality. The voussoirs of both arches were 1.97 ft. thick at the crown, and 3.6 ft. deep at the springings. The mortar used was mixed in the proportion of 5 cwt. of Portland cement to 35 ft. of clean sand. The stone arch gave way when the load piled on the platform reached an amount equivalent to 1.99 tons per foot run, and the brick arch when the load reached 1.81 tons per foot run. Up to the point of rupture the stone arch gave no signs of incipient failure, but, in the case of the brick arch, cracks declared themselves previously, which were apparently caused by the failure of the mortar, the bricks themselves being intact.

"After removing the ruins, a third arch of similar span and rise was constructed for the former consisting of 1 part Portland cement, ½ part broken stone, ½ part gravel, and 1 part sand, whilst the latter consisted of 1 part Portland cement, 1½ parts broken stone, 1½ parts gravel, and 2 parts sand. The total quantity of concrete in the ring was about 50 cubic yards. Two months after completion the centers were removed, during which time the arch was protected from the sun and frequently watered. The testing commenced three weeks after the centers had been removed. Failure took place under a load equivalent to 2.24 tons per foot run on the loaded half of the arch.

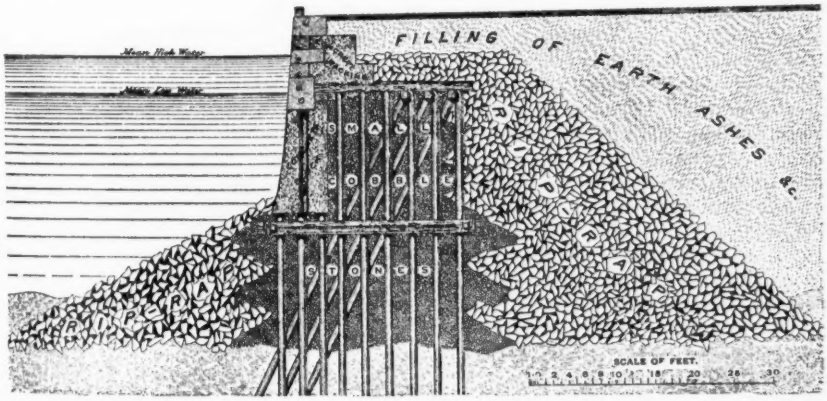
"The next arch to be tested was constructed on the Monier system, the span and rise being as before, whilst the thickness of the ring was 1.97 ft. at the springings and 1.15 ft. at the crown. The concrete used consisted of 3 parts of river sand to 1 part of slow-setting Portland cement. The centers were removed at the end of two months, and arrangements made for testing. Failure took place under a load equivalent to 3.09 tons per foot run of the loaded half. Great difficulty was found in removing the ruins. The metal reinforcement was found intact, having bent, but not broken, at the points of failure.

"The final experiments were made upon a steel arch of the same rise and span as the four preceding ones. This consisted of two steel ribs fixed at 5.9 ft. centers and rigidly braced together. Each rib was of girder section 12.6 in. deep. The total weight of the steel work was 15.6 tons. On testing with a load of 82¼ tons distributed over half the arch, no serious deformation was observed. The load was then removed, and on the next day 158 tons of rails were piled up on the loaded side. The deflection was then considerable, but agreed well with the calculated result. This load was left in place throughout one night, after which rails were piled on the side not previously loaded till a total of 175 tons was reached. The deflection was still further increased, but not a single rivet yielded. The load was then removed, and the experiments terminated. From their experiments the committee concluded that, in arches of large span, the calculations may safely be based upon the theory of the elastic arch. With a view to distributing the load as much as possible in the case of masonry arches, the extrados should be covered with a layer of ballast, which should be at least 3 ft. thick in the case of railway bridges. The safe crushing load on such arches may range from one-tenth to one-fourth the ultimate resistance of the material."

Standard Bulkhead Walls.

THE New York city board of consulting engineers recently presented a report to the commissioners of the department of docks on the construction of bulkhead walls on mud- and on rock-bottoms. *The Railroad Gazette* (Feb. 21) prints the part of the report referring to mud-bottom construction:

"As the bulkhead wall is a retaining wall, which has to resist the horizontal thrust of the earth-filling behind it, and both that earth-filling and the wall itself are floated in mud, the problem of providing a permanent construction becomes a very unusual one. To build a retaining wall on a solid foundation is a simple problem. To build a wall to carry vertical weight only, on a soft foundation, is more difficult. To float a wall in mud, when that wall must also take a horizontal thrust, is a problem which can only be solved by care and experience, no formula or mathematical rules being available. The wall, as now built, is a satisfactory solution of this problem. Your board believes it to be a unique construction, one which is worthy of the most careful study, and which deserves the strongest commendation. The masonry wall is carried on piles, and so floated in the mud. It, however, is not the real retaining wall, but simply a substantial facing, which gives a permanent finish of convenient shape. The same pile foun-



Cross-Section of Bulkhead Wall on Mud Bottom—New York City, Department of Docks.

dation extends back of the wall, and is filled in and around with a mass of rip-rap, which distributes the weight over a large area of the mud, while the whole is braced up by piles driven at an angle. The real retaining wall is the combined mass of rip-rap, masonry, and piles, the whole floated in such a mass of mud that it is practically consolidated into one mass.

"The fact that this wall has settled in places is exactly what was to be expected; it is no proof of weakness or instability; the wall is simply the finished edge of the 250-ft. marginal way, and the whole has settled together; so long as it performs its duty of furnishing practically a vertical surface on the water-side of this way, it is perfectly successful. The function of this wall is that of a practical tool; it is not a monument; though handsome, it is not intended for ornament; it performs none of the functions of the foundation of a building. Its development has been gradual, and it is probable that future improvements will be made; but this board does not hesitate to say that it considers this wall a solution of a very difficult problem, which is remarkable for its originality and the excellence of its results."

Proposed Improvement in the Service of Night Watchmen.

AT a meeting of the officers of the Hartford Fire Insurance Company, Mr. C. F. Simonson, general inspector, delivered an address, in which he showed that the physical nature of night watchmen is not equal to the demands upon it. He cites a number of cases where watchmen have fallen asleep; where they fall asleep for but a short time, and then tamper with the time-clock to cover their negligence; where watchmen have been overtaken, while asleep, by flames; and he says that it is not surprising that, with fourteen hours of watchful monotonous duty and ten hours for eating and sleeping, a watchman sometimes lapses. To quote his own words, published in the *Engineering News* (Feb. 13): "It is evident that watchmen are of little benefit in a building at night, and that even the most perfect watch service will not compel a man to stay awake when nature demands sleep. It is cruel and inhuman for us to exact such a service from any man, and in my opinion earnest effort should be made to lighten their burden by advocating the following plan:

"Select two men capable and fit to be watchmen, sweepers, or helpers; let one begin his shop-work at noon; when the factory closes at night, he takes a round, until satisfied that everything is all right and in proper shape, then eats his supper, which he carries with him, and enters into his regular rounds of watching. He watches until 11.30, reaching home before midnight. The second man relieves him at that time, and watches until 6 A. M., when he eats his breakfast, starts the fire, and opens the factory for employees at 7. Having had breakfast, and the factory open, he is ready to go to his shop-work until noon, when he goes home and returns at 11:30 that night. In this way the expense would be no greater than employing a sweeper or helper during the day and a watchman at night, and each would have one-half day and one-half night at home. It is plain to any one that a man with these hours at home could get the requisite amount of sleep. Change about could be had each week, so that the man who had the first half of the night to watch one week could have the second half the next week and *vice versa*.

"A man that works nights and sleeps days becomes a machine instead of a live man, and it is a common thing to find buildings badly on fire with the watchman taken out suffocated and nearly dead; and in all the big fires in Chicago at night watchmen have been employed. In the Pinkerton watch service the men go on at 7 P. M. and come off at 10; go on at 1 A.M. and off at five. In the watch-tower fire service, from which an average of four hundred alarms are sent out each year, the men are relieved every two hours, so careful are they that they must not sleep. The system has been tried for the past two years by Charles F. Elms Engineering Works and Lyon and Healy Organ Factory of Chicago, who recommend it highly and say that nothing could induce them to change back

to the old system. No man can work continuously fourteen hours at night and be fit for work of any kind, much less that of watching and guarding millions upon millions of property values, in which, it may be, the safety of cities is involved; and I earnestly recommend that this system of watching be proposed, and its adoption secured wherever possible."

Shaft Sinking by Congelation.

WHERE shafts or tunnels are run through strata containing water under pressure, the usual methods of tubbing are very expensive, and the method of freezing the water at the place of excavation has been devised, and is known as the Poetsch process. After some expensive experience in sinking a 78½ m. shaft at a cost of £220 per yard, which involved tubbing and the pumping of 9,000 gallons of water per minute, the engineers of the Auzin Mining Co., adopted the freezing process for sinking two shafts to the coal measures at Vicq in the valley of the Scheldt. The operation and cost of this undertaking are described by Messrs. Saclier and Waymel in the *Bulletin de la Société de l'Industrie Mineral*, and translated in *The Colliery Guardian* (Dec. 13). We abstract as follows:

"The two pits are of unequal size, a smaller one of 3.65 m. diameter being intended for the accessory work of pumping, ventilation, and traveling, while the larger one of 5 m. (16½ ft.) in the clear is to be fitted with cages carrying eight tubs and capable of raising 300,000 tons of coal per annum."

The strata are water-bearing to a depth of 91 m. below the surface. The first level encountered gave a flow equal to 2,700 gals. per hour, while the water in the lower level was under pressure sufficient to make it rise 2½ ft. above the ground. The method of procedure is thus described:

"The borings intended to receive the circulating pipes for the freezing process, which were done by contract by Messrs. Hulster Brothers, are thirty-six in number, of a total length of 3,312 m., twenty of them being arranged in a circle of 6.5 m. diameter around the larger pit, and sixteen on a 5.10 m. circle for the smaller one, all being of the same depth, 91 m. The freezing circuits, which are probably the most important elements in the whole plant, consist of a series of steel pipes, of unequal diameters, the smaller ones, of 30 mm. diameter and 4 mm. thickness of metal, being placed concentrically within the larger ones, which are 116 mm. bore and 7 mm. thick, each series being connected by goose neck to its own ring main. The chilled fluid from the freezing machine passes from one of the rings down the inner tubes, and returns through the outer ones to the surface and back to the refrigerator through the other."

After describing the compressors and other apparatus, the authors state that "the total quantity of ammonia in use in the apparatus was 732 kilogs., which was supplied by Mr. J. Peintre, of Verviers, at the price of 4.25 fr. per kilograme. The calcium chlorid solution in circulation measured 62 cubic metres, and contained 25 tons of the dry salt, also supplied by Mr. Peintre at 150 fr. per ton. The density of the solution was 1.25, corresponding to a specific heat of 0.68 per kilograme or 0.85 per liter."

"The cost of the sinking is given in very full detail in the paper, the total amount having been about £28,400, or £120 per meter, the different items being summarized in the following table:—

	Per cent.	Total. Fr.	Per meter. Fr.
Patentee's royalty	4.6	132,760.00	139.20
Temporary plant	2.7	19,582.40	83.25
Borings for freezing tubes	10.4	73,673.03	313.10
Freezing plant	35.0	248,765.56	1,057.20
Measuring apparatus	0.3	1,898.68	8.10
Freezing	4.7	33,030.95	140.40
Sinking and tubbing	40.5	287,454.77	1,221.65
Carriage	0.6	4,562.00	19.40
Tools	0.7	5,257.00	22.35
Sundries	0.4	2,865.00	12 15
Total	99.9	709,850.39	3,016.80

"The center of the pit was kept as warm as possible, and the temperature never was less than—1.2 deg. Cent. In the chalk a depth of 2½ to 2 m. per day was gone through, though this decreased to 30 to 50 mm. in the harder silicious rock.

"The items specially chargeable to the freezing operations are:

	Fr.
Patent rights	32,760.90
Boring	73,763.03
Erecting	14,084.72
Measuring instruments	1,899.68
Freezing cost	33.030.95
Total	155,448.38

"This sum, corresponding to about 660 fr. per meter, represents all that would have been available for bearing the cost of pumping, temporary lining, and the numerous other charges incidental to sinking in heavily-watered ground, supposing the ordinary method of sinking had been adopted. The coal burnt in supplying steam for the compression was 2,191 tons between the 28th of May and the 28th of December, which, allowing for short time and stoppages, corresponds to about 200 working days. The work developed corresponds to a total removal of 851,656,686 calories, or 461,353,162 calories for the larger and 390,303,706 calories from the smaller pit. About 20 per cent. of the cooling effect was lost at the surface, owing to the distance of the machines from the pits.

"Supposing the whole of the plant to be charged to the single use, its subsequent employment in future sinkings would benefit them to the extent of about 1000 fr. per meter, so that the work could be done for about 2,000 fr. per meter."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

Bridges.

*4148. Van Buren Street Rolling Lift Bridge, Chicago, Ills. Ill. Warren R. Roberts (A thorough description with full structural details). Jour Assn of Eng Soc-Dec. 11500 w.

4263. A Railway Bridge and Building Department. Onward Bates (A well written article examining into the factors which are conducive to the highest efficiency). Ry Rev-Feb. 15. 2700 w.

4342. An Italian Drawbridge (The central span is a lifting leaf 41 ft. 7 in. long and 30 ft. 5 in. wide, operated by hydraulic mechanism). Eng News-Feb. 20. 450 w.

4356. The New York Central Four-track Drawbridge Over the Harlem River (Illustrated description of probably the heaviest railroad drawbridge in the world; it is 400 ft. long, with a depth at center of 64 ft., and weighs 2500 tons. A detail is given of the track-locking apparatus). R R Gaz-Feb. 21. 2700 w.

4393. Proposed Bascule Bridge. Ill. (A counterbalanced swing bridge having a clear opening of 150 ft. and fitted with a novel counterbalance. A subway is provided for pedestrians when the bridge is up). Eng Rec-Feb. 22. 200 w.

4481. The 840-ft. Steel Arch Bridge at Niagara (A description with detailed drawings of the abutments for a bridge to be built over the Niagara gorge, after the designs of Mr. L. L. Buck, with a general account and foundation details, and an ideal view). R R Gaz-Feb. 28. 2000 w.

†4522. The New Papaghni Bridge on the Madras Railway. Harry James Thompson (Paper read before the Inst. of Civ. Engs. The piers consist of two 12-ft. cast iron cylinders, sunk through 60 feet of sand, clay, silt and boulders to rock bottom, and filled with concrete and masonry. The principal cost items are included). Ind & East Eng-Feb. 1. 1600 w.

*4556. Experiments on Arches (An extremely valuable and interesting series of experiments carried out by the Austrian Assn. of Engs. & Archs. on model arches of spans ranging from 4.42 ft. up to 75.4 ft). Engng-Feb. 21. 2000 w.

4648. The Monier Arch Bridge at Draulitten, Germany (Description abstracted from the *Centralblatt der Bauverwaltung*. The arch has a span of 88 ft. and a rise of 21 ft., and bore a test load of 164 lbs. per sq. ft. satisfactorily). Eng Rec-March 7. 1000 w.

Canals, Rivers and Harbors.

*4104. Barry Docks (A well illustrated account of improvements in and about Bristol Channel at Barry. The Lady Windsor lock is fully described). Engng-Jan. 31. 4500 w.

*4109. Cost of Ship Canals. Henry E. P. Cottrell (A table showing the actual cost of excavation on ship canals and the proportion it bears to that of accessory and contingent works. Communicated by the writer as an addenda to his article in the issue of Nov. 29). Engng-Jan. 31. 500 w.

4183. The North River Water Front (A valuable report by the Board of Consulting Engineers, appointed by the Commissioners of the Dept. of Docks, to investigate plans for im-

proving the western river front of the city). R R Gaz-Feb. 14. Serial. 1st part. 3200 w.

*4213. Canals and Navigable Rivers. L. B. Wells (Abstract of a paper read before the Manchester Geog. Soc. An examination into the causes for high rates on inland transportation in England, with valuable statistics). Ind & Ir-Feb. 7. Serial. 1st part. 800 w.

4345. Concrete Locks on the Coosa River, Alabama. Ill. Charles Firth (These government improvements will open up 776 miles of river waterway to steamboats. The work was carried out by U. S. engineers and is fully described). Eng News-Feb. 20. 1700 w.

4348. A Combined Cable Excavator and Conveyor (A simple form of cableway employed in excavating the Suwanee Canal, Ga.; it is fully described and illustrated). Eng News-Feb. 20. 2400 w.

*4384. Canals and Navigable Rivers. L. B. Wells (Paper read before the Manchester Geog. Soc. on inland transportation). Eng, Lond-Feb. 14. 1400 w.

*4385. River Parrett Improvement Scheme. H. G. Foster Barham (A canal scheme is discouraged and the river improvement thoroughly discussed from a practical standpoint. The report is thorough and detailed). Eng, Lond-Feb. 14. 7000 w.

4480. The Mississippi River Improvement (A reply of Mr. J. A. Ockerson to an article by Prof. Johnson criticising the work of the Mississippi River Commission). R R Gaz-Feb. 28. 2000 w.

*4545. The Mexican Drainage Canal. F.H. Cheesewright (Read at a meeting of the Soc. of Arts. An interesting historical account of this great work which it is prophesied will make Mexico the most healthy city in the world). Arch, Lond-Feb. 21. 4400 w.

*4560. The Two New Docks at Portsmouth (The method of construction is fully described and illustrated by drawings. The two docks are each 563 ft. 6 in. long, 120 ft. wide, and 43 ft. 6 in. deep). Eng, Lond-Feb. 21. 3300 w.

†4569. Notes on Dry Docks of the Great Lakes. A. V. Powell (After some historical notes, the author proceeds to describe the construction of the Chicago Shipbuilding Co.'s dry dock in detail, giving many views to illustrate). Jour of W Soc of Engs-Jan. 3500 w.

†4571. Lakes and Atlantic Waterway (Memorandum in regard to certain profiles designed to exhibit the ruling points, and accompanied by four profile sheets. Compiled by the publication committee from the records of the sanitary district of Chicago). Jour W Soc of Engs-Jan. 1400 w.

4658. The Mississippi River Navigation Improvement. J. A. Ockerson (A communication in which the writer corrects some misstatements in a previous number, with a reply from J. B. Johnson). Eng News-March 5. 3800 w.

Hydraulics.

4187. The Nevada County Electric Power Company's Dam in the South Yuba River. Ill. (The dam is forty feet deep, 28 ft. high and 206 ft. long; it is built of timber cribbing bolted to the rock bottom and weighted with 9000 tons of broken granite. Pelton wheels working under 206 ft. head, drive two 300 K. W. Stanley transformers, furnishing light and power to Grass Valley and Nevada City and adjacent mines). Min & Sci Pr-Feb. 8. 500 w.

4303. Flow of Water in a 48-inch Pipe. Rudolph Hering (A discussion of Mr. FitzGerald's paper before the Am. Soc. of Civ. Engs., commending the use of the Chézy formula, $v=c\sqrt{rs}$, and insisting that full description of the conditions to which it is applicable should accompany the presentation of any formula). Eng Rec-Feb. 15. 1800 w.

4344. The Friction in Several Pumping Mains. Freeman C. Coffin (A paper read before the New England Water Works Assn. A tabular statement, with diagram, is given of five different installations of simple and compound pipe relative to the carrying capacity, computed and actual friction. The comparison of computed friction by different formulæ is interesting). Eng News-Feb. 20. 2200 w.

4347. Report on the Yield of the Pequannock Watershed, New Jersey (Mr. C. C. Vermeule recommends an increase of storage capacity and shows at length why he does so). Eng News-Feb. 20. 3900 w.

†4570. New Experimental Data for Flow Over a Broad Crest Dam. Ill. Thomas T. Johnston and Ernest L. Cooley (The method of conducting the field observations, and the results obtained are given in full with tabulated observations. The paper was followed by a theoretical discussion by Mr. Thos. T. Johnston). Jour of W Soc of Engs-Jan. 6000 w.

4649. Method for Approximate Gauging of Rivers C. E. Grunsky (Extract from a report to California Commissioner of Public Works. A method for computing discharge graphically by means of curves). Eng Rec-March 7. 900 w.

†4457. Ways and Means in Arid America. William E. Smythe (An interesting illustrated account of the rise of irrigation on the plains, and its achievements). Cent Mag-March. 6800 w.

*4532. Punjab Irrigation, Ancient and Modern. James Broadwood Lyall (An exceedingly interesting paper read before the Indian section, Feb. 13, from which many valuable hints may be derived by modern engineers in irrigation. Prefaced by remarks from the chairman of the meeting and followed by a discussion). Jour Soc of Arts-Feb. 21. 15500 w.

Miscellany.

*4095. Cast Iron Segments for Railway and Other Tunnels. Evelyn G. Carey (Paper read before the Inst. of Engs. and Shipbuilders. The method of casting and joining the segments is described and fully illustrated while a number of cases are given to show variation in form due to different requirements). Ind & Ir-Jan. 31. 5000 w.

*4102. London Fires and the Brigade (A few notes on London methods of fire prevention

and extinguishing). Eng, Lond–Jan. 31. 1100 w.

*4110. Checking Engineering Calculations. A. Hanssen (A method applicable to tables where the index column differs by constant differences). Engng–Jan. 31. 2700 w.

4149. The Engineer of To-day. St. George Boswell (A paper read before the Applied Science Graduates Society of McGill Univ. The writer includes under the title all branches of engineering, excepting military engineering, and explains the qualifications which are necessary to an engineer, that he may satisfactorily perform the various duties incident to his profession). Can Eng Feb. 4000 w.

4186. American Portland Cement Tests (A time record, from 1 day to 5 years, of tests on cement entering into the construction of five pieces of engineering work, using an aggregate of 310,000 barrels of cement). R R Gaz–Feb. 14. 400 w.

4217. A Proposed Improvement in Arrangement of Service of Night Watchmen. C. F. Simonson (From an address delivered at a meeting of officers and special agents of the Hartford Fire Insurance Company. The author is Gen. Inspector of the company. He suggests the employment of two watchmen in order to prevent the carelessness of one man alone). Eng News–Feb. 13. 1500 w.

4218. The Code of Engineering Ethics Adopted by the Canadian Society of Civil Engineers (Reprint of the full text of the code without comment). Eng News – Feb. 13. 1200 w.

4233. Drying Clay Goods by Hot Floor System. C. J Holman (Two types of drying floors are described; one heated by hot air; the other by exhaust steam). Clay Rec–Feb. 12. 1300 w.

4234. Farm Drainage. John Cownie (A scheme is proposed by which the extensive Iowa swamp lands may be tile drained). Clay Rec–Feb. 12. 1800 w.

4358. The Bulkhead Walls of New York. (Standard sections of bulkhead retaining walls built on mud and on rock bottoms. The Board of Construction Engineers think it an excellent and satisfactory solution of a very difficult problem). R R Gaz–Feb. 21. 400 w.

*4383. Storage of Coal in Hoppers at Battersea (A detailed description of hoppers and steam crane with drawings). Eng, Lond–Feb. 14. 1100 w.

4442 —$1.50. The Strength of Pillars.—An Analysis Leopold Eidlitz (The question examined in this paper is mainly what is the maximum strain in pillars compressed endwise in the center of resistance by weights less than the breaking weights, or by weights not applied in the center of resistance. Diagrams and tables are presented and formulæ deduced and discussed). Am Soc of Civ Eng–Feb. 8500 w.

*4462. The Manufacture of Concrete. Ross F. Tucker (The importance of mixing considered as essential to success as the materials used). Br Build–Feb. 1000 w.

4495. Why I am Attending the Clay-workers' School. E. E. Gorton (Some interesting remarks on this new departure in technical education). Clay Rec–Feb. 26. 2000 w.

4497. The Preparation of Clay. W. A. Eudaly (An interesting paper, by a specialist, upon the properties and treatment of common clays). Clay Rec–Feb. 26. 2200 w.

4538. The Painting of Iron Surfaces. J. Spennrath (Translated by Henry Szlapka from the *Deutsche Bauzeitung*. Alkalies or acids affect paints very strongly. The paper deals with various rust preventive methods in detail and is throughout very instructive). Am Gas Lgt Jour–March 2. 2800 w.

4564. Woodiline for Timber Preservation (Some of the advantages of tie preservation are spoken of and particular mention is made of the effects of woodiline, and also of its properties). Eng, Lond–Feb. 29. 1600 w.

†4572. Cement and Its Uses. Alfred Noble (The writer's notes include many facts and much data of use to cement consumers. A large number of cement tests accompany the communication). Jour W Soc of Engs–Jan. 4400 w.

†4573. Notes on Cement. Ira O. Baker (Influence of water and sand on the quality of cement, and the effect of different methods of moulding and treatment). Jour W Soc of Engs–Jan. 800 w.

†4574. Qualifications of Portland Cement. J. W. Dickinson. Jour W Soc of Engs–Jan. 1200 w.

†4575. Cement and Cement Mortars. Thomas T. Johnson (The author gives the reasons for the failure of cement under ten heads, and appends the results of numerous tests). Jour W Soc of Engs–Jan. 2800 w.

†4576. Experiments on the Elasticity of Concrete. C. Bach (*Zeitschrift des Vereines Deutscher Ingenieure*. The cement was compressed by varying loads and the percentage contraction noted. This was as much as 1.3%). Jour W Soc of Engs–Jan. 800 w.

4642. A French Lighthouse Tower of Concrete (A description with illustrations of a lighthouse tower recently built at Lorient, in the Bay of Biscay. The structure is entirely of concrete). R R Gaz–March 6. 2500 w.

4656. Requirements for Tensile Strength in Cement Specifications. J. M. Porter (The author shows that the personal equation of the person testing the cement enters into the test so largely that the results are not at all reliable. Nine samples were sent to different laboratories whose averaged reports ranged from 75 to 247 pounds. Testing requirements are suggested, among which is abolishing the use of testing machines). Eng News–March 5. 2800 w.

*4690. The Demolition of a Mill Chimney at Manchester (The chimney, which was over 11-ft. in diameter, and 270 ft. high was underpinned on one side and these props burned out, resulting in the collapse of the structure). Eng, Lond–Feb. 28. 1200 w.

We supply copies of these articles. See introductory.

DOMESTIC ENGINEERING

Advances in Heating and Ventilating Tall Office-Buildings.

EXISTING defects in the heating and ventilation of tall office-buildings have been frequently alluded to in these pages. The imperative need for something better has directed the attention of able engineers to the subject. That they will ultimately succeed in adding to the other advantages of this modern type of architecture the further merit that such buildings shall, at all times and seasons, be wholesome and comfortable places for the transaction of business seems certain, in view of some of the recent work done in New York and other American cities.

A notable example of these improved installations is one designed by Mr. Alfred R. Wolf, of New York city,—an engineer who has for a considerable period made a specialty of designing heating and ventilating apparatus for tall office-buildings, and who has successfully met and surmounted many of the difficulties that attend the satisfactory solution of a very difficult problem.

The installation referred to is in the building of the American Surety Company, in New York city. A description of it, with plans and illustrations of details, is presented in the *Engineering Record* (March 7). Some of the leading features are described in the following abstract.

A combination of direct and indirect methods has been adopted. There are twenty-one stories in the building. Up to and including the seventh story, the indirect method is used. For the remaining fourteen stories the direct method is employed. The fourteen upper floors, under such conditions, will doubtless be no worse or better in respect of heating and ventilation than a fourteen-story building having the same floor plan and heated wholly by the direct method. The seven stories heated by the indirect method will be far superior in wholesomeness and comfort to the rooms of most tall office-buildings.

Forced circulation is maintained through the indirect heating and ventilating system. "Each room is provided with several vent registers opening into ducts carried up to the roof alongside of the interior columns near the stairway or alongside of the columns in outside walls. As the air-supply is only warmed to about the temperature of the rooms, a direct radiator is placed under every window in the building to take care of the transmission of heat from the window, and to counteract any down draft from external pressure. The first seven stories are supplied with fresh air for the purpose of ventilation by means of a blower. This air can be heated to any desired degree, preferably about room temperature in the winter-time, while an abundant supply of air of external temperature is furnished in the summer months.

"All of the rooms above the seventh floor are heated entirely by direct radiation. The heating and lighting plants and their accessories occupy about two-thirds of the basement, while the remainder, which is on the Pine street side of the building, is occupied by a bank. To begin with the details of the ventilating plant, we find that the air-supply is drawn into a covered chamber in the south-east corner of the building, and in this is located an 8-foot Sturtevant blower capable of furnishing about 35,000 cubic feet of air per minute. The fan is driven by a belt from a 20 horse-power ideal engine. Beyond the fan is a nest of heating coils containing 2,050 square feet of surface, composed of 7-foot two-row sections arranged in three groups with 1¼-inch pipes 8 feet high above the bases. The heater is provided with a by-pass controlled by a mixing damper operated by a thermostat placed in the duct leading from the blower. Between the fan in the blower and the heater two branch ducts, one 24×18 inches and the other 14×18 inches in size, take their origin and supply cold air to the boiler- and engine-rooms; the ducts are of suffi-

cient size to change the air in these rooms once in every six minutes. The main duct from the heater is 80×34 inches in size. It branches into a number of smaller ducts, which, bending with long, easy curves, supply the vertical flue. It was specified that the inside radius of all bends should not be less than the width of the duct. Generally speaking, the vertical flues have a depth of 8 inches and a width depending upon the amount of air they are to carry. One 20×30-inch duct supplies a nest of entirely independent flues, each leading to a different floor of the building. The designer of the plant lays considerable stress upon the increased value of this subdivided system over the method of employing one large fresh-air shaft supplying horizontal ducts branching to each floor. It is said that a much more uniform distribution can be obtained with individual ducts."

The vertical flues are largely carried up inside of the exterior columns, through which also the risers are run. These flues are of No. 24 galvanized iron, with fronts cut away. "The edges are bent outward into a lip to receive a galvanized-iron front. Angles are doweled into the fireproofing at the sides of the opening, and to the angles are screwed moveable cast-iron panels reaching from the floor to the ceiling. These panels may be removed, and, after taking off the front of the duct, the riser lines will be accessible. The vertical flues have at their base a curved sheet-iron deflector, to avoid the friction when the air turns upward from the duct into the flue. Each warm-air flue has two register boxes, one about 18 inches and the other about 8 feet from the floor. To prevent the register boxes from being injured or put out of shape while the masonry was being put in, each was fitted with boards of 1½-inch stuff containing numerous 1½-inch holes, so that it might at the same time act the part of a register for temporary heating of the building. A top and bottom vent register is provided for each vent flue."

In some instances hot-air flues are continued higher than the floor which they supply with air, the portions above this being used for ventilating flues. In such cases the part of the flue above the warm-air register is separated from the lower part by a partition. "As far as possible, the riser and return lines are carried up through the vent flues, and, as these pipes are not covered, the heat from them serves to create an upward draft in the flues. All of the vent flues from the first to the seventh floor are run independently up to the level of the ninth floor, where each group is drawn together into one flue. All vent flues extend up above the roof, and are provided with suitable protecting caps, except the vent flues in the shaft surrounding the smoke-stack. These extend only to the level of the eighth floor, where they combine into one flue.

The toilet-rooms are ventilated by a separate system of flues leading to the roof, and the air in them is exhausted by a Blackman fan discharging through a copper elbow looking upward. The vent flues containing the riser lines are provided with elliptical openings between the ceilings and floors for branches to radiators. This allows for the expansion and contraction of the risers, and, as the flooring is of solid fireproof construction, there is no chance for any leakage from the flues at the openings between the ceilings and floors for branches to radiators. Each horizontal supply and return pipe to a radiator is inclosed in a sleeve of No. 24 gage galvanized iron.

"Each riser line is about 300 feet long, and each line was anchored at points 75 feet from the top and bottom, while, midway between, an expansion joint consisting of a return bend or loop about 8 feet long was placed. Some interesting tests were made on joints of this character by Mr. Wolf and the contractor, and it was found that, with a 4-foot bend, a deflection of 1¼ inches could be produced without introducing a permanent set on the piping; but it required a terrific strain, it is said, to produce this amount of motion in the loop. With an 8-foot return bend a motion of 2½ inches was produced, and this was the size selected."

The article affords a fine study in means and methods of surmounting the difficulties in the heating of tall buildings.

The Use of Disinfectants and Antiseptics.

IN a paper "On Disinfection," written by the celebrated bacteriologist, Koch, he intimated that disinfecting agents commonly regarded as inefficient might become sufficiently active, if used at a higher temperature; and he suggested investigation into the effects of temperature upon the activity of substances known to possess antiseptic properties. In 1889 Professor Scalji of Rome published results of experiments upon increase of antiseptic effect in corrosive sublimate through increase of temperature in a weak solution of that salt. These facts, with allusions to results of further experiments by Behring and Heider, are noted by A. G. Young, M.D., secretary of the Maine State board of health, in *Journal of Medicine and Science*, and have been reprinted in *The Sanitarian* for January. The following are some of the results of Heider's experiments as given by Dr. Young. These experiments were directed to the effect of the disinfectants upon anthrax spores.

"Carbolic acid, 5 per cent. solution, at ordinary room temperature, not destroyed in from thirty to forty days; at 40° C. (104° F.), four hours; at 55° C. (131° F.), from three-quarters to two hours; at 75°, C. (167° F.), from three to fifteen minutes.

"Pure carbolic acid and sulphuric acid, equal parts of each by weight, 5 per cent. solution, at 40°, in two hours; at 55°, in thirty minutes; at 75°, in one minute.

"Pure cresol and sulphuric acid, equal parts of each, 5 per cent. solution at 40,° in one hour; at 55°, in five minutes.

"Lysol, 5 per cent., at 60° C. (140° F.), sterilization not effected in two hours; at 80° C. (176° F.), sterilization complete in five minutes.

"Sulphuric acid, 1 per cent., at ordinary temperatures, sterilization not effected in seven hours; at 75° C., sterilization in seventy minutes.

"Caustic potash, 5 per cent. solution, at temperature of room, failed to sterilize in eight to ten hours; at 55° C., spores destroyed in three-fourths to two hours; at 75° C., in two to ten minutes.

"Hot water at 70° C. (158° F.), in eight to nine hours; at 85° C. (185° F.), in forty to forty-five minutes; at 95° C. (203° F.), in fifteen minutes."

Dr. Young assigns "several" explanations of the reason why warm solutions of disinfectants show a more energetic germicidal action than cold solutions. One is the well-known fact that the intensity of chemical action increases with increasing temperature; another is that moderately-elevated temperatures favor the functional activity of bacterial life, and therefore the rapidity with which poisons are absorbed. But, when we have to do with sporeless bacteria,—and that is the case in nearly all of the real work of disinfection,—we have the direct coöperation of moist heat in destroying its vitality, even when the increase in temperature is hardly more than moderate.

"Practical applications of the results of these investigations readily occur. In the first place, they suggest a grave doubt as to the efficacy of some processes of disinfection and antisepsis as they may be carried out during the cold season. Next they teach the great advantage of using antiseptic and disinfecting solutions warm or even hot.

"When the articles to be disinfected can be subjected to the action of the solution for only a short time, as in washing floors or other woodwork, wiping down walls, or rubbing articles of leather or upholstered furniture which cannot be disinfected otherwise, rapidity and certainty of action should be increased by increasing the temperature of the disinfecting solution."

Planning Heating and Ventilating Installments.

THE *Master Steam Fitter* for February has a good article upon this important subject. The writer begins with the proposition that, "when the work is well planned, more than half the difficulties are overcome." We should be inclined to amend this proposition by substituting the word "*all*" for the words "more than half." There are rarely any serious difficulties in the mechanical execution of a well-planned job, and any difficulties that arise owing to obstructions in the way of the

proper application of principles and natural laws ought to be overcome in making the plans. The drawing-board is the place to work out ways and means, modifications, and allowable compromises, where principles are concerned; and, where any problems of this character are permitted to remain unconsidered, in the hope that they may be solved in some way during the erection of the installation, the latter cannot be said to have been "well planned."

The time will come when contractors will revolt against bidding for unplanned work. They will also revolt against planning work to be estimated for by themselves in competition with other concerns who also plan their own work. The system of presenting complete heating and ventilating plans for competitive bids is growing in favor with architects, and, when the competition is free, with such plans rigidly adhered to, and where none but reputable contractors are invited to compete under the assurance that the lowest bidder will get the contract, no injustice can result, and a plant as good as plans and specifications call for will be assured.

The article under review describes the system employed by D. K. Burnham and Co., a firm of Chicago architects. In planning the work for a building every detail is said to be carefully figured out in the office of this firm before bids are called for. "For this purpose they have in their employ high-salaried, skilful engineers in each department, who plan the work to the finest detail, so that nothing is left for the contractors but to follow the plans. Contractors appear to appreciate this method, because it leaves less for them to do and enables them to do the work with greater dispatch and in the most satisfactory manner."

The plans of the Ellicott building, designed by this firm, are instanced as models of their kind; portions of these plans are presented in the article, as specimens of thoroughness in indicating even minute details. From such a plan the bidder is able to calculate with great accuracy the cost of material, and to judge the amount of labor required in erection. All details of radiating surface, its location and distribution, are given. It would seem that no room is left for misunderstanding, but, should any arise, it can be settled definitely by reference to the plans and specifications.

Mr. C. N. Wilkes, the engineer in charge of this department of D. K. Burnham & Co.'s office business, asserts that, although this thoroughness in planning heating and ventilation installments costs considerable money, the expense is more than saved in the work of erecting; so that, as a measure of economy, it is advisable to draw the plans as near to perfection as possible. It hardly needs to be said that this accuracy involves nothing more than diagrammatic drawings, but the calculations must be made with nicety in the apportionment of heating surface, and in specifying sizes of pipes and fittings.

Hygienic Conditions of Bakeries.

BEFORE the last meeting of the Public Health Association, Dr Jürgensen said that while in nearly all continental countries the conditions of milk supply and meat supply had been made much more wholesome during recent years, that bakehouses, except in Holland, were still very defective from a hygienic point of view. The public, he states, do not show much interest in this question, but would undoubtedly become alarmed if certain features of this trade became generally known. According to Dr. Jürgensen, the principal grounds of complaint are that in the larger towns the bakeries are underground, sometimes in the neighborhood of places of convenience, and that the bakers take their meals in the workrooms. As overwork is quite common in this trade, the health of a good many of the men is very bad, for the inhalation of dust and particles of flour favors the development of tuberculosis, and the considerable variations of temperature produce rheumatism. Numbers of the men also suffer from deformities of the lower extremities, and from want of necessary cleanliness diseases of the skin are very frequent among them. Dr. Jürgensen said that matters are much better in England, where some progress has been made mainly through

the efforts of the medical profession. He suggested that underground bakeries should be abolished, that they should be situated on the ground level, and should not be in close connection with dwelling-houses. The floor should be made of polished material so that it may be easily cleaned, all the corners of the rooms should be rounded, and the bakers should wear a working dress that can be washed. A model bakery should have a room in which articles of clothing may be deposited, and a lavatory with bathing accommodation. There should be separate rooms for shaping the dough, cooling, and fermenting, and all the rooms should be ranged round a central office, from which all that goes on may be viewed. The bakers should be divided into two parties, and four hours a day spent in cleaning.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Domestic Engineering in the American, English and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

Heating and Ventilation.

4207. Heating, Lighting and Ventilating the Capitol. W. L. Crounse (Illustrated description). Safety V–Feb. 2500 w.

4208. "The Breakers," Newport, R. I. (Heating, lighting and elevator running machinery in the country seat of Cornelius Vanderbilt). Safety V–Feb. 1500 w.

*4297. Heating a Theatre-Plant in the Pabst Theatre, Milwaukee, Wis. (Illustrated detailed description). Dom Engng–Feb. 800 w.

4423. Planning the Work (This article is an able argument, with examples of practice in planning heating and ventilating installments, to sustain the proposition that careful planning brings final success at least cost). Mas St Fit–Feb. 1200 w.

4424. Forced Blast Warming With Furnaces. George W. Kramer (Read at the second annual meeting of the Am. Soc. of Heat. and Vent. Engs. Mr. Kramer is the architect to whom the recent impulse in this system of warming buildings is chiefly due, and his paper is full of valuable practical information upon the subject). Mas St Fit–Feb. 4400 w.

4425. Heating and Ventilating of Large Churches. H. B. Prather (Abstract from paper read at the meeting of the Am. Soc. of Heat. and Vent. Engs. The exact requirements of each particular case carefully ascertained, should be the basis of the whole procedure in the design of the plant, in which co-operation of the architect and engineer are considered as essential to high success). Mas St Fit–Feb. 2600 w.

4441. The Pillet Thermophore for Heating Rooms. Ill. (A method of greatly increasing the effect of an open fire-place in heating apartments, while at the same time retaining the advantage of such fire-places for ventilation, as heretofore). Sci Am Sup–Feb. 29. 450 w.

4444. Heating and Ventilation of the Freehold High School (Illustrated detailed description with plans). Heat & Ven–Feb. 15. 1600 w.

4445. A Combination Heater. "Knight" (A practical dissertation on combination systems of warming). Heat & Ven–Feb. 15. 1900 w.

4523. Steam-Heating in a Country Hotel (Detailed description with plans). Eng Rec–Feb. 29. 600 w.

4650. The Heating and Lighting of the American Surety Building (Illustrated description with plans of one of the most complete heating-plants, comprising the most advanced methods, that has yet been placed in a tall office building; with a description of the electric lighting installment, also comprising the latest improvements in the art). Eng Rec–March 7. 3000 w.

Landscape Gardening.

†4179. Horticulture at Ghent (A review of the development and condition of the industry with reference to it as a source of American supply). Con Rept–Jan. 7000 w.

*4265. The Garden in Relation to the House. F. Inigo Thomas (Extracts from a paper read before the Applied Art Section, Society of Arts). Brit Arch–Feb. 7. 3500 w.

4309. The Surroundings of Statues and Monuments (Editorial on the effect of its environment upon a work of art, and the effect of the work upon its environment. Considered specially in regard to the placing of the Sherman statue in Washington). Gar & For–Feb. 19. 1200 w.

4542. The Garden in Relation to the House. F. Inigo Thomas (Full paper read at the Soc. of Arts, with discussion). Am Arch–Feb. 29. 9000 w.

Plumbing and Gas Fitting.

*4295. Fastening Bowls to Marble Slabs. Edwin S. Marsh (Good practical directions for properly doing the work). Dom Engng–Feb. 450 w.

*4296. An Elaborate Bath Room (Illustrated detailed description of a superfine piece of work). Dom Engng–Feb. 300 w.

Miscellany.

*4359. The Berlin System of House Sanitation. Gerard J. G. Jensen (The remarkable backwardness of this city in systems of house sanitation and drainage is in this article contrasted with its remarkable progress in other branches of engineering). San Rec–Feb. 14. 1700 w.

*4533. The Influence of Subsoil Water on Health. S. Monckton Copeman (Brief running review of the various theories, facts and fancies, which have been advanced by observers, and pointing out things that have not yet received merited attention, or concerning which no satisfactory conclusions have yet been reached). San Rec–Feb. 21. 1500 w.

We supply copies of these articles. See Introductory.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading, and Domestic Engineering.

Steam Engines for Lighting Plants.

UPON this subject Mr. Francis B. Crocker, in *The Electrical Engineer* (Dec. 25), has shown that something remained to be said, if only to give the results of experience in an industry of so recent date and so phenomenal growth as electric lighting. His article is a plain, unprejudiced, and impartial statement of requirements, which close observation of electric-lighting plants has recognized as essential to best results.

First, the wisdom of the old maxim that it is not wise to "put one's fish all in a single bucket" is recognized in his statement that "the number of units in a large central station should be sufficient" to prevent any material interference with the operation of the plant, if one, or even two, of them should be disabled. This is a principle that needs to be observed not only in those manufacturing establishments whose output is dependent upon power, but in those wherein constant running and uniformity of effect or product are required; and it is valid for a refrigerating plant, or for some water-pumping stations, as well as for an electric-lighting central station. While this is a point upon which there will be general agreement, "the relative size" of the units will be variously judged. Some will advocate uniformity of power; others will desire different engine capacities. The first secures the advantage of interchangeability of parts; the second also has its conveniences, and one of its results may be an increased all-day efficiency of the plant. An example illustrating this point is cited.

"In an isolated plant with which the writer is familiar, there is one engine and dynamo of 750 lights capacity, and one of 250 lights, giving a total capacity of 1,000 lights. During the day and late at night the smaller engine can be run very economically with the load, which varies between 100 and 200 lights. When the load increases at the approach of darkness, the larger engine is substituted for the smaller, and supplies power for the 500 to 700 lights which are used during the evening. In this way each engine is almost perfectly suited to its load for long periods of time, the interval between the light load of the day and the heavy load of the evening being so short that the larger engine has to run for only a few minutes at an uneconomically light load, and for an unusually large load both engines can be run at the same time. In the design of central stations a similar judicious selection of engines may give excellent results. For instance, large compound or triple-expansion engines may be operated almost continually to carry the permanent portion of the load with high economy, but for the maximum load, which usually lasts only an hour or two, simpler and cheaper engines may be used."

The possible selection of engines "so that at no time would any one of them be running below 60 or above 125 per cent. of its normal load" is thus indicated. "Ingenuity and judgment" are required in selecting engines that will secure maximum convenience and efficiency. Small engines are usually simple, while large ones will be compound or triple-expansion.

Direct coupling is the simplest and most desirable arrangement, when circumstances admit of its employment, provided its adoption does not "involve sacrifices which offset its advantages . . . . The engine and dynamos must run at the same speed" in this arrangement; but, whereas it is perfectly practicable to run dynamos at from 500 to 1,000 turns per minute, engines have not as yet been made that can take this speed permanently, safely, and economically. For these reasons the sys-

tem of direct connection has such limitations that, for the most part, transmission of power from engines running at low speed to the dynamos running at higher speeds is and will continue the ruling method. For this purpose Mr. Crocker prefers belting, upon which he remarks:

"Belt-connection has the following advantages: (1) it enables almost any desired ratio of speed to be obtained in a convenient and simple manner; (2) it is cheap; (3) it is applicable to almost any case, provided the space be sufficient; (4) the machines are almost entirely independent, so that either the engine, or dynamo, or both, can be changed, repaired, or operated without interfering with each other; (5) the dynamo is perfectly insulated so far as the belting is concerned, since the latter is almost always made of non-conducting material.

"The general disadvantages of belting are: (1) it requires considerable space, since the machines must be placed a certain distance apart in order to make the belt work properly; (2) the action is not positive, there being a certain slip even in normal working, and, in case of an overload or other trouble, the belt may run off the pulleys, or break; (3) belting sometimes causes unsteadiness in speed, owing to its slipping or flapping on the pulleys, which may produce flickering of the lights; (4) for the same reasons, it may give out noise; (5) belts exert a side pull on the bearings which causes friction and wear.

"The last difficulty can be largely overcome by proper design and attention. Dynamos have been run for years with very little wear in the bearings. The loss of power is also smaller than is often supposed. In fact, belt-connected dynamos have a higher efficiency at light loads, because there is less material than in direct-coupled machines to cause frictional and magnetic losses."

Individual Electric Motors.

IN an article by Mr. Oberlin Smith in *Electric Power* (Feb.) the above title is defined as referring to a motor "driving some particular machine (usually in a machine shop or factory) . . . . to which it is especially adapted . . . . in contradistinction to the employment of a motor for driving a line of shafting" through which, by any devices, as belts, gears, sprockets, etc., it imparts motion to "separate machines." Mr. Smith is fertile in happy forms of expression for mechanical ideas, and this term seems an excellent one for the class of motors he discusses in his article. We shall endeavor to give as complete a summary of this article as space will permit in the following abstract.

Although the use of electro-motors for street cars, boats, ventilating fans, and some other individual devices dates back five or six years, it was for some reason considered too radical a departure from old methods to attach such a motor to a lathe or a planer or a driller.

"One reason for this was doubtless the comparatively greater efficiency of the large motors, the manufacturers then having not learned how to make the small ones as efficient as they now do. Another reason probably was the big cost of all motors, and the frequent repairs. The latter difficulty has already nearly vanished, owing to better general design, the use of mica as an insulator, and of carbon rather than metallic brushes upon the commutator. Still greater relief has come, and is yet to come in increasing degree, from the use of induction motors, especially of the polyphase type. Than such a machine as one of these last-mentioned motors it is impossible to imagine anything simpler, unless we compare it with the well-worn analogues of a coffee-mill or a grindstone. When such a machine is properly built, it has but one moving member, and that a symmetrical one, of cylindrical form, attached to an ordinary shaft, revolving in self-oiling journals. Such a mechanism is the *non plus ultra* of absolute simplicity, and practically requires neither attendance or repairs."

The entire practicability of individual motors can no longer be questioned. How about their economy? Mr. Smith has much to say upon this point. As a measure of economy, he evidently favors the substitution of "group-driving motors" (another happy and useful expression) for very

small units, when this plan can be conveniently carried out.

"This part-way of compromise methods is in many cases a good one, especially during the transition period, as oftentimes shafting already in use can be separated into shorter lines; and groups of tools can be segregated so as to be run independently in regard to times and seasons, as well as to speed, from the general mass of machinery in the shop. Oftentimes two such short pieces of shafting can be placed lower down than usual, perhaps against a wall or a set of posts, thus allowing more head room for the introduction of cranes, etc. Such grouping of tools, to be actuated by a group-driving motor, is sometimes especially desirable where the room required is very small, as baby motors of a mere fraction of a horse-power capacity have not as yet been made as efficient nor as cheap, in proportion to their power, as have the larger ones, say of one horse-power and upward. This discrepancy, however, time will doubtless remedy to a considerable extent. In the present state of the art, a decision between this group-driving and a strictly individual system must be arrived at in each particular case, according to the special conditions present."

The final question of economy must, however, be decided upon the conditions of working. But the conditions of to-day will be improved. There cannot remain any doubt that the electro-motor of the future will be cheapened. Not perhaps by any marked change in its form, but by new methods of manufacture, so that the element of first cost will be less.

The cost of power, for many purposes, is so small a factor of current expense that it does not, as compared with steam power or gas-motor power, weigh much in the balance of advantages secured by the use of individual electric motors, or group-driving motors, in a shop or factory employing a considerable variety of machines, especially such as must, from the nature of their work, run intermittently.

The advantages set forth by Mr. Smith as gained by individual motors are, in brief, the gain in clear space above machines; increased overhead light available from sky-lights, etc.; additional cleanliness of shops; reduction of noise; increased safety to life and limb; easy and independent control of speed of any particular machine; "adaptability of electric motors to all sorts of machine tools, sometimes as component parts of these tools themselves," which, "when the tools can be of special design," effects in many cases a considerable saving in their cost; independent action of each individual motor, or group of motors; increased facility for locating any machine in any desired place in a shop; and last, an advantage set forth in the following quotation:

"Not least among the advantages of such an open-spaced, well-lighted, clean, quiet shop as has been pictured is its influence in affecting the morale of the workmen. The tendency of such a plant, in comparison with the old-fashioned one, will inevitably be to make men not only cleaner, brighter, and better, but also quicker in their methods of work, on account of the general influence of the electricity genii in the air, so to speak, and the facility with which they can quickly obtain high speeds temporarily for such parts of the work as require them.

"It seems to the writer that the coming of a fashion for the general equipment of new shops with individual motors for many of the machines therein is merely a question of time, and that, it is to be hoped, a comparatively short time. The chief retarding influence will doubtless be the present high cost of small motors. This is to be regretted, but certainly no one can be blamed for it, as electrical companies have all been at an enormous expense in experimentally developing the beautiful and highly-effective motors which they have already produced. They have also been at considerable expense in the way of litigation and competition in selling. Furthermore, they have not, so far, been able to sell these motors in large enough quantity to justify them in going to the expense of making the special tools, and of 'stocking up' with the large batches, which would make possible a really cheap production. It will doubtless be the case,

however, that demand and supply will react upon each other, until we shall see some of the methods now used for the production of sewing machines, guns, typewriters, and so on, applied to bringing forth motors in batches of thousands at a time, at a price marvellously less than it was originally supposed they could possibly be produced for. This is obviously possible with sufficient refinement in labor-saving devices, as the raw materials in a motor amount to but a small portion of its total cost."

Electrically-Lighted Life Buoys.

THE far-reaching applications of electricity to all the affairs of life is well illustrated in two articles which have appeared in the interval since our March number went to press. One of these is in *The Electrical Engineer* (London, Jan. 31), and is an attempt to reproduce (feebly, as is confessed) some of the gorgeous effects obtained by ingenious electric lighting in a celebrated pantomime now being presented to crowded houses at a London theater. From this phase of usefulness, wherein the subtle force is made to minister to the public amusement, it is a long step to the situation of a shipwrecked mariner floating by the aid of a life buoy, in the darkness of night, at sea, and in imminent danger of being overwhelmed and lost without being once perceived by any human eye, or receiving the succor that would be generously and joyfully extended could he make known his deadly peril. But even in such a situation can electricity aid the search; and the encouragement which a person in such a peril would feel in knowing that he can be seen, should any friendly eye chance to pass within the limit of vision, would certainly be no insignificant part of the benefit conferred by the simple application of electric lighting to life buoys described in an article in the *Electrical Review* (Feb. 12).

One of these electrically-lighted life buoys has been tested on board the light-house tender *Armeria* with most encouraging results, and has been favorably reported upon to the light-house board in Washington, by Commander West, U. S. N.

The buoy is of large size; its body is a hollow ring of suitable material; a battery suspended by a tubular frame pivoted to the ring depends from the ring, and a tubular metal support for an electric lamp rises to a position above the ring.

The tubular frame for supporting the battery, and the support for the lamp, constitute what, as a whole, may be called a frame, to which the ring buoy is journaled at diametrical points, as described below.

"The ring of the buoy is normally in the plane of the frame; when the buoy is dropped into the water, the ring on which the buoy floats turns so as to rest on its side on the water, and so on turning operates an automatic switch controlling the lights. At the lower end of the frame is the battery box containing the cells. To keep this perfectly dry inside, a moisture absorber is placed there with the cells. The box cover is easily removable, and made water-tight by a packing of rubber with wax or tar. The frame work passes from the ends of the battery box upward, meeting to form an arch over the ring. On top of this arch is the lantern, a glass globe covering one or more pairs of incandescent lamps. Electrical connection between these lamps and the battery cells are through the tubes of the framework on both sides. On each side of the frame is a switch box containing the automatic switch controlling the circuit. The ring is mounted upon trunnions journaled in the switch boxes. Where the trunnion enters the switch box, it is surrounded by a water-tight stuffing box to better protect the switch. The stationary contacts of the switch are secured to the ring trunnions, but, of course, both sets of contacts are insulated from their supports. The contacts are so related to each other that the turning of the ring but a very small angle out of the plane of the frame will close the circuit, and the lamps will remain in circuit and lighted until the ring can be turned around nearly one complete revolution. This precaution is very important, because it will ensure the continuous glow of the lamps in a rough sea.

"Such are the principal features of the machine. There are a few other interest-

ing details added. One is a hand switch concentric with the lantern, added merely by way of precaution; it is so arranged as to be able to switch on one pair of lamps at a time, or turn off all of them. The lamps are in parallel; they are used two at a time, to economize battery power; if one lamp of any given pair of lamps has a filament break, the other can supplement it until another pair of lamps can be switched on. Another addition is a bell below the lantern, automatic or other, which will be of value as a fog signal. The handle of the hand switch is surrounded by a water-tight stuffing box, like that of the automatic switch."

The Present Development and Future Possibilities of Electricity.

IN the first of a series of articles with the above title published in *American Machinist* (beginning Feb. 13.) Mr. William Baxter, Jr., takes a very sensible view of the subject, and predicts that in the applications of electricity, or in the conversion of mechanical power into the form of energy which we call electricity, nothing revolutionary is to be expected.

As regards the telegraph and telephone, he takes the position that any improvements that are possible in these lines will be of far more interest and importance to the great corporations which control them than to the general public, and he makes a good argument in support of the proposition that the present methods in use for electric lighting and power are here to stay, and that, although inventors may probably be able to produce electrical appliances which will enable them to go into the general market and compete on a more or less favorable footing with existing machines and appliances, these latter are not in the least likely to be superseded.

Mr. Baxter very justly surmises that investment of capital, though it has been very great, would yet have been much greater, had it not been for a prevalent fear of investors that what is valuable now may at any time deteriorate in value, or even be rendered worthless, by some new, great, and revolutionary invention or discovery. The root of this fear he finds in the current notion that the science of electricity is in its infancy, and that there remains a much larger residuum to be learned than has yet been ascertained about it. There are those who will even assert the admitted fact that we really do not know what electricity is, as though this was true only of electricity, thus making it of special significance as to the strides likely to be made in this field in the future. We do not know what electricity is, or gravity, or matter, or heat, or light. We have theories and useful working hypotheses, but no knowledge. Yet we have been able, through all these agencies, to make remarkable progress. We have learned much of the modes of action of matter under the influence of force; but what is force? The definitions in the text-books are based only upon what force does, not upon what it is. No eye has beheld force, no chemical or physical investigation has been able to isolate it. Some have even denied its existence as an entity, preferring to regard it as the sum of all pre-existences. There has been no end of speculation upon its nature, but it remains insurmountable, and even incomprehensible except in its effects. The knowledge of the nature of electricity is, therefore, no more in its infancy than is our knowledge of the nature of heat, light, and gravity.

"As the layman knows nothing about the conditions required to produce a certain result, he will accept any statement made in relation to the subject as within the limits of possibility. If he is told that the day may come when ten, or even a hundred, times as much power will be obtained from a given amount of electric energy as at the present time, he will likely believe it. Owing to this fact, a great many men hesitate about investing either in electric machinery or electric enterprises, as they fear that at any moment someone is liable to come forward with an invention that will render all present devices practically useless.

"It seems worth while, therefore, to ask and endeavor to answer how much foundation there is for these fears,—in other words, how well grounded is electrical

practice, and how clearly can we see what is likely to be the course of future development?

"In the first place, it should be noted to how small a degree new devices have superseded old ones in the past. The first of the modern applications of electricity to be reduced to practice was the arc light. Following this came the incandescent light; but the latter did not supersede the former. On the contrary it occupied a new field of its own. Similarly, the alternating-current system did not supersede the direct-current. Its effect was to render practicable the distribution of electric light over longer distances; but in its own field the direct current is still preferred. In the same way the polyphase system has opened up new possibilities of achievement, but no one expects it to supersede the systems that went before it. So far as electric generators and motors are concerned, revolutionary improvements seem simply impossible. These machines are nothing but converters of energy,—the generator being a converter of mechanical into electrical energy, and the motor a converter of electrical into mechanical energy. These conversions are made at a loss ranging between about seven and twenty per cent. according to the size of the machine; and it will be seen that the margin for improvement in this direction is small. The direction in which improvements in the machines of this class will be made in the future will be in the mechanical details; but even in this direction it will not be possible to make revolutionary advances, as the design of the modern machines has been carried to a high state of perfection. Although improvements in design and construction may be made in the future, they will not be of so much value as to render machinery now in use valueless, any more than the gradual improvement of the steam engine has rendered the older engines valueless. The development that we may expect in electrical machinery will not be so much in the way of improvements on present apparatus as in the adaptation of motors and generators to new uses and devices."

The Coming Electrical Exposition in New York.

NEW YORK city is to have an electrical exposition, commencing on May 4 next and continuing until June 1. The exposition is to be held under the auspices of the National Electric Light Association in connection with its nineteenth convention, and we are assured that it promises to be the largest and most interesting display of electrical apparatus of all kinds ever made in this country, not excepting the displays made at the World's Fair at Chicago, and recently at Atlanta. The exposition will be held in the great Industrial Building, which occupies the entire block on Lexington Avenue between Forty-third and Forty-fourth streets. Many novel and unique features in electrical displays will be introduced in connection with the exposition. There will also be a series of popular and practical lectures on electrical subjects by eminent scientists, and afternoon and evening concerts by famous military bands, with special spectacular effects; all of which will be open to the general public. It is probable that the exposition and convention will, together, constitute the most notable electrical event of the year on this continent.

ABERDEEN, Scotland, possesses the unique position of producing the electric light cheaper than any other city of the United Kingdom. The charge to consumers is only 4d. per unit. *The Electrical Review* (March 6), in making this statement adds that between 1894 and 1895 the amount of load in the generating station was doubled. There are at present 17,000 incandescent and 80 arc lamps connected with the central station, 110-volt incandescent lamps being chiefly used, but 3,000 are of 220 volts. The maximum load averages 2,000 amperes at 110 volts. Seven machines, two of 200 H.P., two of 80 H.P., and three of 40 H.P. are in use. Steam is supplied by two Babcock and Wilcox boilers. The longest circuit worked from the station is about 1½ mile. The plant also supplies 1,000 lamps at the British Railway Station, 200 at the Aberdeen *Gazette* offices, and lights the infirmary.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Applied Electricity in the American, English and British Colonial Electrical and Engineering Journals—See Introductory.

Lighting.

*4081. Lighting Residences by Electricity. Augustus Wall (Showing the variety of conditions to be met in arranging electric lights for the different parts of a costly residence, the methods to be followed, and the precautions to be observed). Eng Mag–March. 3000 w.

4126. Electric-Lighted Life Buoys. James H. Bates (Illustrated description of a device, the invention of C. J. Bates). Elec Rev–Feb. 12. 1100 w.

4131. Dielectric Strength of Oils under Alternating Potentials. Elihu Thomson (Facts sustained by experiments and tests with oil). Elec Eng–Feb. 12. 1300 w.

4137. Economical Results in Modern Isolated Arc Lighting. F. E. Drake (A paper read at the Milwaukee meeting of the Northwestern Elec. Assn. Contains an itemized account and description of the plant owned by J. L. Hudson, Detroit). Elec Wld–Feb. 15. 400 w.

4142. A Commercial Aspect of the Incandescent Lamp. George R. Metcalfe (An examination of the causes that have brought about the unsatisfactory condition of the lamp trade, and considerations that tend to place the competition along the line of quality). Elec–Feb. 12. 2400 w.

*4236. Electric Lighting Acts, 1882 and 1888 (Regulations issued by the Board of Trade for securing the safety of the public, and for ensuring a proper and sufficient supply of electrical energy). Eng, Lond–Feb. 7. 4800 w.

4401. An English Engineer's Views on Arc Lighting Progress. John Hesketh (Also gives a brief summary of the present state of this particular branch of the electrical industry in England). Elec Engng–Feb. 1800 w.

4453. Can the Cost of Isolated Lighting Be Reduced? George R. Metcalfe (The importance of testing lamps, and of determining whether the maximum amount of light is being received for the power generated, etc). Elec–Feb. 26. 2800 w.

4598. Western Electric Iron Clad Arc Dynamos (Illustrated description). Elec Eng–March 4. 2800 w.

4629. A Theatre Electrical Plant (Illustrated description of the installation of the new Olympia theatre, of New York). Elec Wld–March 7. 1400 w.

4670. Electric Light Plant at Chamberlain, S. D., Operated by Artesian Well Power (Illustrated description). W Elec–March 7. 1300 w.

Power.

*4119. Some Characteristics of Synchronous Motors. E. Kolben (From the *Elektrotechnische Zeitschrift*. A contribution to practical knowledge). Elec Eng, Lond–Jan. 31. 1200 w.

4125. Table for Determining Sizes of Commutator Segments (A chart constructed by W. B. Cleveland intended for use in calculating the angular thickness of commutator segments). Elec Ry Gaz–Feb. 8. Table.

4127. Electricity on the Brooklyn Bridge (Illustrated description of a successful test made Feb. 8). Elec Rev–Feb. 12. 1000 w.

4130. Westinghouse Two-Phase Power Plant in the Milwaukee Harvester Co.'s Works (Illustrated description). Elec Eng–Feb. 12. 1200 w.

4167. Electric Driving at the Works of Wm. Wharton, Jr. & Co., Inc., Philadelphia, Pa. (Illustrated description of a machine shop laid out with electric distribution as the key to the arrangement, with reasons which led to the introduction). Am Mach–Feb. 13. 1400 w.

*4199. The Art of Electric Welding (Illustrated account of a visit to the works of the Electric Welding Co. The process due to Prof. Elihu Thomson is explained, and testimony as to its value is given). Elec Rev, Lond–Feb. 7. 2800 w.

*4201. Zerener's Method of Electrical Casting, Welding and Soldering. Ill. From the *Electrotechnische Zeitschrift* (A report on this method and the latest type of apparatus employed). Elec Eng, Lond–Feb. 7. 1100 w.

*4259. Individual Electric Motors. Oberlin Smith (The term defined. The purpose of the article is to take a general glance at the up-to-date development of the electrical system in question. The advantages of individual motor driving are considered). Elec Pow–Feb. 3600 w.

*4260. Note on the Design of Condensers. Harold B. Smith (The practical design and capacity of plate condensers). Elec Pow–Feb. 500 w.

*4261. The Armature. W. H. Freedman (Lecture delivered before the Henry Electrical Club. The various types are classified and illustrated, and an attempt made to present a somewhat logical treatment). Elec Pow–Feb. 1600 w.

*4262. Mechanical Connections between Engines and Dynamos. Francis B. Crocker (Lecture delivered before the Henry Electrica Club. Direct coupling, belting, shafting, rope driving and other apparatus are considered). Elec Pow–Feb. 7000 w.

*4287. Plastic Bond Tests at Buffalo (Some tests on the conductivity of rail joints with plastic bonds. A Weston millivolt meter was used which had just been recalibrated at the factory). St Ry Rev–Feb. 15. 500 w.

4311. A Modern Alternating-Current Station (Illustrated description of the United Electric Light & Power Co. in New York. Station designers desiring to install new plants would do well to carefully study the numerous original methods in this installation). Elec Wld–Feb. 22. 1400 w.

We supply copies of these articles. See Introductory.

*4408. Theory and Calculations of Asynchronous Alternate Current Motors. A. Heyland (This method of calculation is based upon the practical adaptations of certain peculiar results, at which the author arrived in submitting the phenomena of mutual induction to a graphical treatment. The first part deals with polyphase motors,—deduction of theory and practical applications of the deduction). Elect'n-Feb. 14. Serial. 1st part. 2500 w.

4443.—$1.50. The Twenty-eighth Street Central Station of the United Electric Light and Power Company. H. W. York (Illustrated description, submitted by the author because he believes that in this station are embodied a number of features somewhat unusual in central station design). Trans Am Soc of Civ Engs-Feb. 4400 w.

4451. How to Install an Electric Motor for Blowing Church Organs. S. H. Sharpstein (The problems about such plants are discussed, and explanations of means used to overcome many difficulties). Elec Eng-Feb. 26. 3800 w.

4454. Indicated Evolution in the Storage Battery. Leonard Paget (The writer does not believe the storage battery has been developed to its highest perfection. He considers the subject of its possible evolution by careful study of the constituent elementary parts, viz., the electrolyte, the positive and the negative plates). Elec-Feb. 26. Serial. 1st part. 2000 w.

*4553. The Harrison-Street Electric Supply Station, Chicago (A full description of this latest and best representative of modern American practice, with illustrations). Engng-Feb. 21. 3000 w.

*4583. Present Day Types of Accumulators (A specially contributed article in which the writer proposes to deal with the subject from the standpoint of the owner of a private house lighting installation). Elec, Lond-Feb. 14. Serial. 1st part. 2200 w.

*4586. Electric Elevators. William A. Gibson (General information in regard to the Otis electric elevator). Elec Rev, Lond-Feb. 21. 1600 w.

4619. The Building of a Great Dynamo. H. L. A. (Illustrated description dealing with the machine shop work, and with the winding department operations in natural sequence, as the work is put through the shops). Am Mach-March 5. 1700 w.

4620. Dynamo and Motor Testing. Robert A. Ross (It is the purpose of this article to give a full description of the apparatus and operations involved, so that anyone slightly familiar with electrical terms and appliances may understand and make the tests). Am Mach-March 5. 2200 w.

4628. Water-Power Electric Plants in the United States. Bushrod C. Washington, Jr. (An extensive illustrated article which will be of interest to the general electrical reader as well as to the engineer). Elec Wld-March 7. 3000 w.

4632. Electricity at Niagara Falls. W. E. Tuttle (A description of the plant, in process of construction, of the Niagara Falls Hydraulic Power and Manufacturing Company which it is thought will produce the cheapest power for the money invested of any in this country). Elec Wld-March 7. 1800 w.

*4723. Electrically Controlled Clocks. J. Warren (Some of the ways electricity is utilized in connection with the driving and regulation of clocks. Illustrated by two diagrams). Elec, Lond-Feb. 21. 600 w.

Telephony and Telegraphy.

4138. A New System of Telegraphy (Illustrated description of patents granted Dr. Isidor Kitsee for two systems of signaling, in which high-frequency, but comparatively low-pressure alternating current is used for transmission, and vacuum globes are employed as receivers). Elec Wld-Feb. 15. 500 w.

4143. The Starting of the Telephone Exchange at Chicago. H. H. Eldred (The first of a series of articles on early telephone history. In succeeding articles much unpublished history bearing upon the Berliner patents will be given). Elec-Feb. 12. 1800 w.

4314. How the Bell Telephone Patent was Saved in England (Personal reminiscences of H. H. Eldred). Elec-Feb. 19. 2000 w.

*4387. The Telephone Question. Alfred R. Bennett (Paper read before the East of Scotland Engng. Assn. A consideration of the telephone interests in England, as compared with other countries, with an effort to answer the question why the good results abroad may not be repeated in England). Ind & Ir-Feb. 14. Serial. 1st part. 2800 w.

4402. A Practical Automatic Telephone Exchange System. Charles K. Munns and Fred DeLand (Description, well illustrated). Elec Engng-Feb. 3300 w.

*4411. The Telephoning of Railways. Ill. J. Pigg (Suggestions for the most efficient arrangement of telephone circuits in their adaptation to the special requirements of the railway service). Elec Eng, London-Feb. 14. 2400 w.

*4434. Military Telephony (Illustrated description of the P. Charollois system). Elec Rev, Lond-Feb. 14. 2000 w.

4455. Building a Telephone Exchange in London. H. H Eldred (An account of the difficulties in securing rights from property owners for the running of telephone exchange lines). Elec-Feb. 26. 700 w.

4633. Telephony at Cripple Creek. J. W. Dickerson (A brief historical account). Elec Wld-March 7. 2700 w.

Miscellany.

4111. Electricity Simplified. Nelson W. Perry (The first of a series of papers, written in popular style, aiming to give a clear understanding of this subject). Sci Mach-Jan. 15. Serial. 1st part. 1200 w.

4168. The Present Development and Future Possibilities of Electricity. William Baxter, Jr. (An article in two parts. The first number deals largely with the present and the causes that have retarded progress, but begins to examine the future prospects). Am Mach-Feb. 13. 2000 w.

4174. Magnetic Tester for Sheet Iron (An apparatus devised by Prof. Ewing is described, also the operation of testing). Sci Am Sup-Feb. 15. 1000 w.

*4267. The Effect of Temperature on the Resistance of Paraffin and Resin Oil. H. P. Gaze (Investigations confined to the behavior of paraffin and resin oil, at various temperatures within the range met with in commercial apparatus). Elect'n-Feb. 7. 1400 w.

†4277. Magnetic Permeability of Iron and Steel. Max Osterberg (The principal object of the article is to call attention to the great value of thorough chemical analysis, of a perfect knowledge of the amount of temper a particular piece of iron or steel has undergone). Sch of Mines Quar-Jan. 1700 w.

*4286. Lightning Arresters. W. R. Garton Abstracts from a paper read before the Chicago Elec. Assn. The essentials of a good arrester and things to be considered in placing, etc). St Ry Rev-Feb. 15. 1400 w.

*4293. Alternate Current Transformers (Abstract of Dr. Fleming's third Cantor lecture). Engng-Feb. 7. 1200 w.

4317. Electric Heat in Dental Practice. Dr. Levitt E. Custer, in the *Southern Dental Journal* (The value of electric heat in dentistry is shown by explanation of its many applications). Sci Am-Feb. 22. 1000 w.

4318. Chase's Electric Cyclorama (Illustrated description of an invention which may bring panoramas into fashion again). Sci Am-Feb. 22. 700 w.

*4390. Modern Applications of Electricity. S. T. Harrison (The first of a series of articles on electric lighting, dynamo management and construction, etc., especially written for practical engineers. This number consists of introductory remarks, and the design, construction and working of continuous current dynamos and motors). Prac Eng-Feb. 14. Serial. 1st part. 4000 w.

4400. The Protection of an Invention. W. Clyde Jones (The object of the paper is to present some of the facts relating to our patent system, in a manner to be of service as working knowledge to electrical engineers and others engaged in inventive pursuits). Elec Engng-Feb. 4500 w.

4405. Study of the Fuse Problem and Solution. William McDevitt (Tests, lessons and remedy). W Elec-Feb. 22. 3200 w.

*4406. Industrial Electrolysis in 1895. Bertram Blount (A survey of this industry aiming to indicate the direction in which progress is being made and those in which further progress is possible). Elec Plant-Feb. 2300 w.

*4409. The Reichsanstalt Standard Wire Resistances. K. Feussner and St. Lindeck (Abstract from the *Wissenschaftl Abhandl der Reichsenstalt*). Elect'n-Feb. 14. 4500 w.

*4415. Alternate Current Transformers (Abstract of the last of Dr. J. A. Fleming's Cantor lectures on the above subject). Engng-Feb. 14. 1200 w.

4432. Heat from Electricity. J. E. Talbot (Electric heating is considered in this number largely in its application to cooking). Elec Rev-Feb. 26. Serial. 1st part. 1500 w.

*4435. The Blot Accumulator (This invention by G. R. Blot is said to merit careful consideration). Elec Rev, Lond-Feb. 14. 1500 w.

4438. Vacuum Tube Illumination by the D. McFarlan Moore System (Illustrated description). Sci Am-Feb. 29. 1300 w.

†4512. The Velocity of Electricity. Ill. Gifford Le Clear (Investigations tending to show the relation between electricity and light). Pop Sci M-March. 1100 w.

*4558. Magnetization of Iron. Ernest Wilson (A lecture delivered before the Engng. Soc., King's College, London. The time rate of growth of magnetization of iron, and its importance to the electrical engineer). Engng-Feb. 21. 2000 w.

†4578. Modern Theories of Electrolysis. Dr. Joseph W. Richards (Reviews concisely the facts and laws of electrolysis and the attempts to explain observed facts and proven laws by postulating relations which have not yet been fully proven). Jour Fr Inst-March. 8000 w.

4600. Computations for Coil Windings. J. B. Baker (A discussion, giving formula for predetermining the proper dimension and size of wire in winding a coil). Elec Rev-March 4. 700 w.

†4623. Notes on the Theory of Oscillating Currents. Charles Proteus Steinmetz (The object of the article is to present a short outline sketch of a modification of the method of complex imaginary quantities, applied to oscillating currents). Phys Rev-March-April. 3000 w.

†4624. An Experimental Study of Induction Phenomena in Alternating Current Circuits. F. E. Millis (Circuits containing resistance and self induction are discussed in this number. In a further communication the writer expects to consider experiments made upon circuits containing capacity). Phys Rev-March-April. 2000 w.

†4625. Demagnetization Factors for Cylindrical Rods. C. Riborg Mann (Investigations carried on in the physical laboratory of the Berlin University, under the direction of the late Prof. Kundt and Prof. Warburg). Phys Rev-March-April. 2500 w.

†4626. A Photographic Study of Arc Spectra. Caroline Willard Baldwin (Illustrated description of apparatus and outline of the work, with results). Phys Rev-March-April. Serial. 1st part. 3500 w.

4630. Electrical Discharge in the Atmosphere and in Vacuum Tubes. John Waddell (The object of this article is to give a short synopsis of the main facts already known concerning electrical discharge, both in the air at atmospheric pressure and in gases in a rarefied condition, before Röntgen's discovery brought the phrase "cathode rays" into current newspaper literature). Elec Wld-March 7. 2000 w.

*4707. The Lessing Dry Cell. R. Mullineux Walmsley (Report on tests made). Elect'n-Feb. 28. 3500 w.

We supply copies of these articles. See introductory.

INDUSTRIAL SOCIOLOGY

Condition of Labor in England Compared With Its Condition in Other Lands.

UNDER the title "Reasonable Patriotism," the Earl of Meath has contributed to the *Nineteenth Century* an interesting paper, in which he contrasts the condition of labor in England with its condition in other lands. In this connection he has much to say concerning labor troubles in the United States. He asks and answers the question whether the introduction of reforms during the last thirty or forty years "has increased, as much as might be reasonably expected, the sum total of the contentment or happiness of the nation," answering it rather hesitatingly and dubiously, as in the following quotation:

"I am far from saying that rich men and women in England devote enough time and money, or attention, to the wants of the poor, the sick, and the suffering. Far from it. I believe the reverse to be the case. All I assert is that, whatever may be our own shortcomings, no other country can show as good a record.

"Our rich men are paupers compared with those of America. The incomes of our landed classes, owing to agricultural depression, have been cut down twenty-five, fifty, and even seventy-five per cent. Their responsibilities remain the same. A county magnate, as well as the humblest squire, has to build and repair farmhouses, cottages, fences, and roads. He is expected to head every subscription list, to take the lead in every philanthropic movement within the district, to assist his church, and to be the general almoner of the distressed of the neighborhood.

"The American millionaire is the absolutely irresponsible master of his own wealth. He possesses no great country mansion or estate, nor has he any hereditary position to support. The public opinion of his neighbors often demands of the English nobleman that he shall maintain the great house in proper condition, and keep up a state commensurate with his social position. The palace, castle, or manor house, with its park and gardens, often bears an historical interest, and is not unfrequently more enjoyed by the public than by himself. If he were seriously to curtail his expenditure, he would be accused of penuriousness, of selfishness, of want of consideration for his poorer neighbors, and the loudest in denunciation would probably be the tradesman who, having for years declaimed in the local radical club against the extravagances of the rich, had suddenly felt, through his pocket, inconveniences arising from the shrinkage in the length of the account annually placed by him for payment in the hands of the great man's agent.

"Every man, woman, and child born on the English magnate's or country gentleman's property considers that he has a certain right to look to him for assistance in the days of distress. No such obligation rests upon the American Dives. The result is that we hear of men who have died in the United States worth as much as £2,000,000 a year. They are able to accumulate. The English land owner is not permitted to do so, even if he should have the wish. In contrast to such enormous incomes, I doubt very much whether any resident native of Great Britain can show a clear income of £500,000 a year. I know, however, of one nobleman in England (and probably there are others) who spends about £60,000 a year in charities alone, quite irrespective of all the good he does for the poor on his own property."

Speaking of the vague feeling among the poorer classes "that the laws and institutions of the country are somehow or other responsible for much of their sufferings," and of the belief entertained by many "that in other countries, particularly in republics, greater freedom is to be found than under a constitutional monarchy, and that the interests of the poor are not as much considered in Great Brit-

ain as in some foreign lands," particularly in the United States, he says that this feeling and this belief are not justified by facts. To sustain this position the labor difficulties in the United States, and conclusions derived from them, are dwelt upon in the paper. He quotes John Burns as saying that, during his recent visit to America, he saw slums that would make a Whitechapel slummer blush, and evidence of degradation the like of which he had never seen in London.

In the matter of taxation he thinks the English workman's condition superior to that of American workingmen. He quotes approvingly the *Chicago Times* as saying that "the Chicago system of taxation is systematized crime against the poor," and that this burden has rested upon them for twenty years, and he evidently regards that system of taxation as typical of the burdens imposed upon the poor throughout the land. On the other hand, he alleges that "in Great Britain the workingman, if a teetotaler, may live in comparative comfort without contributing to the revenue of the country."

In short, the purpose of the article is to urge the growth of a "reasonable patriotism" in the rising generation of Britons, by teaching them that, while there are many things in the English social structure to be lamented and even deprecated, it is, on the whole, a better country to live in than any other on the globe, not even excepting the United States. Probably there are some of American birth and education who would accord with this view.

We cannot go into all the details of the comparison made between England and other lands, but it must be confessed that a very strong argument is made in support of the main contention that "the Old Country is, after all, not a bad place to live in," and that the rising generation ought to have the fact impressed upon their minds as a part of their education. As a whole, this is one of the most interesting and instructive of the contributions to the sociological literature of the month. The optimistic tone of the paper contrasts strongly with most current sociological literature.

The Industrial Revolution in Japan.

THE marvellous progress in all the arts of civilization made by the Japanese within the last three decades has no precedent in the history of nations. In another department their creation of a mercantile marine of no mean proportions in the short space of twenty-five years is noted. Mr. William Eleroy Curtis, in an article of twenty pages in the *Bulletin of the Department of Labor* for January, tells the wonderful and interesting story of Japanese progress in the manufacturing industries. Of this article we make the following abstract, presenting some of the more interesting features of a great social and industrial transformation.

We are told by Mr. Curtis, who writes from personal observation in Japan, that that country is becoming less and less dependent upon foreign nations for the necessities and comforts of life, and that she is making her own goods with the greatest skill and ingenuity. Studying the methods of all civilized nations, the Japanese have adopted those of each which seem to them most suitable, and have rejected what is of no value to them as often as they have adopted those things which are to their advantage.

It is only forty years since the ports of Japan were forcibly opened to foreign commerce. It is only twenty-eight years since the first labor-saving machine was set up within the limits of the empire. The exports and imports now exceed $115,000,000. A table of the kinds and values of imports shows that their general character corresponds very favorably with those of the older civilized countries.

In 1894 Japan exported goods to the United States amounting to $21,661,779; to France, $9,749,388; to Hong-Kong, $8,099,740; to China, $4,406,994; to Great Britain, $2,975,099; to British India, $1,844,079; and to Germany, $758,774,—a total of $49,495,853. Japan also exports goods in small amounts to nearly every nation in the world.

In the same year she imported goods from Great Britain of the value of $21,094,937; from China, $8,755,753; from the United States, $5,491,279; from British

India, $5,280,224; from Hong-Kong, $4,499,859; from Germany, $3,954,771; and from France, $2,174,024,—a total of $51,250,847.

The industrial revolution that is now going on in Japan is quite as remarkable as the political revolution that occurred there thirty years ago, and equally important to the rest of the world. Until recently, all the manufacturing done in Japan has been in the households, and ninety-five per cent. of the skilled labor is still occupied in the homes of the people and in a measure independent of the conditions that govern wage-workers in other lands. The weaver has his loom in his own house, and his wife, sons, and daughters take their turns at it during the day. It has always been the custom for children to follow the trade of their parents. The finest brocades, the choicest silks, the most artistic porcelain, cloisonne, and lacquer work, are done under the roofs of humble cottages, and the compensation has heretofore been governed usually by the quality of the piece produced.

"The ancient system of household labor is being rapidly overturned by the introduction of modern methods and machinery. The older artisans are offering a vain resistance, and can not be drawn from their antique looms and forges by any inducement that has yet been offered; but the younger generations are rapidly acquiring a knowledge of the use and value of labor-saving machinery, and factories are being built in all parts of the empire. The greatest progress thus far has been made in cotton spinning and weaving, but several iron mills have been established, and machine shops are springing up all over the empire. In four years the new treaties go into effect, when foreigners will be allowed to engage openly in manufacturing enterprises. Then their capital and experience will give a decided stimulus to mechanical industry, and the increase in the productive power of Japan will be even more rapid than now.

"The first manufactory established in Japan was a cotton mill down in the southwestern corner of the empire, in the province of Satsuma, which has produced the best pottery and some of the greatest men. Prince Shimazu was its patron. Having learned something of modern arts and sciences from the Dutchmen who were allowed to remain on the island of Deshima, he started a laboratory on his estates in which he learned telegraphy, photography, and how to make glass, coke, and gas for illuminating purposes. A few years later he built a factory near his summer villa, which was half arsenal and half iron foundry. He made guns there and other articles of iron, and experimented with explosives.

"All the work in both institutions was conducted under his personal supervision, with the assistance of Dutch chemists, from whom he heard that much could be learned about such matters from books. So he started a retainer to Nagasaki, charged with the duty of securing whatever books on chemistry, natural philosophy, and other scientific subjects could be bought or borrowed. And an order was left with a merchant at Deshima to procure for him a copy of every scientific publication that was issued. In this way a considerable library accumulated, and the books were translated to the prince, as fast as they came, by a schoolmaster who had learned English at Deshima and whose services were secured."

The next factory was erected in Tokyo in 1867 Starting with 720 spindles, it now operates 82,000, and is the largest in the empire. In 1879 two more were started, four more in 1880, four more in 1881, one in 1882, another in 1883, and another in 1884. Started by the government, these have all passed into the hands of private owners. Their number has increased to 61, operating 580,564 spindles, and employing 8,889 male and female operatives,

The first genuine foreign factory to be established in Japan is the Osaka Tokei Seizo Kubushiki Kwaisha, familiarly known as the American Watch Company. It was started on January 1, 1895, and turned out its first finished watch on April 10. The organizer and promoter of this company was Mr. A. H. Butler, of San Diego, Cal., who took an outfit of watch-making machinery to Japan, and induced a number

of jewelers and watch-dealers in Osaka to furnish $160,000 capital to pay the cost of a building and the running expenses of the business. The company is incorporated under Japanese law, and the stock is all in the name of Japanese citizens, although one hundred and forty of the three hundred shares actually belong to Mr. Butler and his associates.

As no foreigner is allowed to engage in manufacturing outside of certain limited districts in the treaty ports of Japan, pending the enforcement of the new treaties in 1899, it was necessary for Mr. Butler to evade the law, which he did, with the knowledge and consent of the authorities, by having his stock issued in the name of Japanese trustees, who assigned to him the certificates in blank and gave him a written agreement to protect his interests. At the end of four years Mr. Butler will have the stock registered in his own name, and become an officer of the company. An American superintendent and nine assistants were employed to instruct native workmen. These gentlemen say that their Japanese students show very great aptitude and skill, and that they learn much more rapidly and have a much more delicate touch than persons of similar intelligence and condition in the United States. Nearly all of them had had some experience in making or repairing watches and clocks before they came into the factory, and a few had used hand-machines for drilling, polishing, and that sort of work; but the modern machinery at which they were placed was entirely new to them. They are mostly young men, aged from eighteen to thirty. As none of them can understand a word of English, and none of the American experts could speak Japanese when they arrived, the work of instruction might have been very slow but for the keen perception of the pupils.

It is said that the quickest way to instruct the Japanese in any handicraft is to go through the process and let them look on. Almost instantly they are able to repeat, and to continue repeating it, perfectly. Labor is attainable at very low prices. The native watchmakers get about twenty cents a day as the highest wages, the lowest being five cents a day. A tabulated statement of wages for all occupations is given, the average for each being very low. Many further particulars of great interest are given in this paper, which will well repay the reading.

Socialism for the Millionaire.

A PAPER under the above title by Mr. George Bernard Shaw, in the *Contemporary Review* for February, is one of the most interesting contributions to the sociological discussions of the month. It is not the less to be styled thoughtful, because parts of the paper are enlivened by a fine vein of humor. All sparkling wines are not good wines because they sparkle. But Mr. Shaw's paper may be compared to a rare quality of champagne, which, even if it were a still wine, would yet be good and valuable. Samples of this humor are found in the following quotations:

"The millionaire class, a small but highly interesting one, into which any one of us may be flung to-morrow by the accidents of commerce, is perhaps the most pitiably neglected in the community. . . . In reviewing the advertisements of the manufactures of the country, I find that everything is produced for the million and nothing for the millionaire. . . . . Whilst the poorest have their Rag Fair . . . . where you can buy a book for a penny, you may search the world in vain for the market where the £50 boot, the special cheap line of hats at forty guineas, the cloth-of-gold bicycling suit, and the Cleopatra claret, four pearls to the bottle, can be purchased wholesale. Thus the unfortunate millionaire has the responsibility of prodigious wealth without the possibility of enjoying himself any more than any ordinary rich man."

A single exception to the millionaire's limitations is named in the quotations below; but this is of a nature which can hardly contribute much to his comfort in life.

"The millionaire can have the best of everything in market, but this leaves him no better off than the modest possessor of £5,000 a year; there is only one thing that he can order on a scale of special and recklessly expensive pomp, and that is his fu-

neral. Even this melancholy outlet will probably soon be closed. Huge joint-stock interment and cremation companies will refuse to depart to any great extent from their routine of Class I, Class II, and so on, just as a tramway would refuse to undertake a Lord Mayor's Show. The custom of the great masses will rule the market so completely that the millionaire, already forced to lead nine-tenths of his life as other men do, will be forced into line as to the other tenth also."

Let it not, however, be supposed that the millionaire fills no important *rôle* in the economy of the universe. He has a use, which like the X-rays and argon, has only recently been suspected and traced to definite discovery. We are not sure that Mr. Shaw himself ought not to be credited with the honor of this discovery; at any rate, he has formulated the true function of the millionaire as a factor in human existence. The millionaire creates needs, and converts luxuries into necessities. Thus it may be some recompense to him to feel that his life has even this much influence upon his environment; but his disappointments and sufferings are numerous and peculiar to his class. "Indeed, in many things he cannot enjoy himself more than many poor men do, nor even so much; for a drum-major is better dressed; a trainer's stable-lad often rides a better horse; the first-class carriage is shared by office-boys taking their young ladies out for the evening; everybody who goes down to Brighton for Sunday rides in the Pullman car; and of what use is it to be able to pay for a peacock's-brain sandwich when there is nothing to be had but ham or beef? The injustice of this state of things has not been sufficiently considered. A man with an income of £25 a year can multiply his comfort beyond all calculation by doubling his income. A man with £50 a year can at least quadruple his comfort by doubling his income. Probably up to even £250 a year doubled incomes mean doubled comforts. After that the increment of comfort grows less in proportion to the increment of income, until a point is reached at which the victim is satiated and even surfeited with everything that money can procure. To give him another hundred thousand pounds, under the impression that you are benefiting him, and on the general ground that men like money, is exactly as if you were to add two hours to the working-day of a confectioner's employee on the general ground that boys are fond of sweets. What can the wretched millionaire do that needs a million? Does he want a fleet of yachts, a Rotten Row full of carriages, an army of servants, a whole city of town houses, or a continent for a game preserve? Can he attend more than one theatre in one evening, or wear more than one suit at a time, or digest more meals than his butler? Is it a luxury to have more money to take care of, more begging letters to read, and to be cut off from those Alnaschar dreams in which the poor man, sitting down to consider what he will do in the always possible event of some unknown relative leaving him a fortune, forgets his privation? And yet there is no sympathy for this hidden sorrow of plutocracy. The poor alone are pitied. Societies spring up in all directions to relieve all sorts of comparatively happy people, from discharged prisoners in the first rapture of their regained liberty to children revelling in the luxury of an unlimited appetite; but no hand is stretched out to the millionaire, except to beg. In all our dealings with him lies implicit the delusion that *he* has nothing to complain of, and that he ought to be ashamed of rolling in wealth whilst others are starving."

And, as civilization advances, his plight gets worse instead of better.

"The old-fashioned tradesman, servile to the great man and insolent to the earner of weekly wages, is now beaten in the race by the universal provider, who attends more carefully to the fourpenny and tenpenny customers than to the mammoth shipbuilder's wife sailing in to order three grand pianos and four French governesses. In short, the shops where Dives is expected and counted on are only to be found now in a few special trades, which touch a man's life but seldom. For every-day purposes the customer who wants more than other people is as unwelcome and as little

worth attending to as the customer who wants less than other people."

What is the millionaire to do with his surplus funds? "The usual reply is, provide for his children and give alms. Now, these two resources, as usually understood, are exactly the same thing, and a very mischievous thing too. From the point of view of society, it does not matter a straw whether the person relieved of the necessity of working for his living by a millionaire's bounty is his own son, or merely a casual beggar of no kin to him. The millionaire's feelings may be more highly gratified in the former case; but the mischief to society and to the recipient is the same. Even the private feeling in this matter is changing, and changing rapidly. If you want to spoil a young man's career, to annihilate his efficiency and enfeeble his character, clearly there is no method surer than that of presenting him with what is called 'an independence,' meaning an abject and total dependence on the labor of others."

The paper regards the alternative of giving huge sums to trustees "to do good with" as mischievous. "There is no getting over the fact that, the moment the attempt is made to organize almsgiving by entrusting funds to a permanent body of experts, it is invariably discovered that beggars are perfectly genuine persons: that is to say, not 'deserving poor,' but people who have discovered that it is possible to live by simply and impudently asking for what they want until they get it, which is the essence of beggary. The permanent body of experts, illogically instructed to apply their funds to the cases of the deserving poor only, soon become a mere police body for the frustration of true begging; and consequently of true almsgiving. Finally, their experience in a pursuit to which they were originally led by natural benevolence turns them to an almost maniacal individualism and an abhorrence of ordinary charity as one of the worst of social crimes. This may not be an amiable attitude; but no reasonable person can fail to be impressed by the certainty with which it seems to be produced by a practical acquaintance with the social reactions of mendicity and benevolence."

The remainder of this excellent paper is an arraignment and criticism of the prevailing system of public charities, which is regarded as actually fostering the growth of the classes for whose relief it is intended to provide.

THE revenue of Western Australia continues to expand. In January the colony's income was £130,729, an increase of £30,414, or roughly, 30 per cent. The main item of increase came from customs duties, which rose £20,984, or over 50 per cent. The primary cause of the all round increase is due to the development of the goldfields.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Industrial Sociology in the American, English, and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

*4082. The Scotch System of Branch Banks. J. Selwyn Tait (Showing that the National and State banks lock up $750,000,000 of capital, which the adoption of the Scotch branch bank system would release for purposes of enterprise). Eng Mag-March. 3500 w.

*4083. The Money Question and Constructive Enterprise. John R. Dunlap (Designed to present the subject from the standpoint of the engineer, architect, and practical men generally, and showing the essential importance of sound finance to progressive industrial development.) Eng Mag-March. 4200 w.

†4139. Socialism for Millionaires. George Bernard Shaw (The thrusts of this writer are made with a keen and polished blade. The unfortunate millionaire is considered as bearing the responsibility of enormous wealth without the possibility of enjoying himself any more than an ordinary rich man, and sympathy is extended to him for being in this pitiable plight. It is on the whole concluded that the function of the millionaire in the economy of the universe is to create needs and to raise mere luxuries to the, so to speak, higher power of necessities. Thus he becomes a benefactor to the human race). Contemporary Rev-Feb. 6800 w.

4151. Municipal Control of Street Car, Water and Gas Plant (Considers the control as the natural and rightful tendency of progress). Can Eng-Feb. 1400 w.

†4154. The Poor Colonies of Holland. J. Howard Gore (Dr. Gore was the U. S. Com. Gen. to the International Exposition at Amsterdam in 1895. The information embodied in thi article was collected by him during a visit to the

We supply copies of these articles. See introductory.

poor colonies in July of that year. This interesting account shows that as compared with impoverished people of other lands, the poor colonies of Holland are in a much better condition. They are not abased by their benefits, nor caused to feel that they are paupers by acceptance of gratuities. The system is a good sociological study). Bul Dept of Labor-Jan. 6500 w.

†4155. The Industrial Revolution in Japan. William Eleroy Curtis (The facts on which this article is based were collected by Mr. Curtis, personally, while in Japan during the past year. Values stated in American gold on the basis of 2 silver yen to the dollar. It was only forty years ago that the ports of Japan were forcibly opened to foreign commerce. It was only twenty-eight years ago that the first labor saving machine was set up in that country. The exports and imports now exceed $115,000,000. The article gives an account of this wonderful progress, and a forecast of the industrial future of the Japanese). Bul Dept of Labor-Jan. 7700 w.

†4156. Recent Reports of State Bureaus of Labor Statistics (Colorado, Illinois, Maine, Maryland, New Hampshire, Ohio). Bul Dept of Labor-Jan. 8000 w.

†4157. Trade Unions in Great Britain and Ireland (General digest of the Seventh Annual Report of the Labor Dept. of the British Board of Trade, so far as it deals with trade unions. Contains an array of reliable statistics). Bul Dept of Labor-Jan. 1700 w.

†4158. Wages and Hours of Labor in Great Britain and Ireland (Synopsis of a report on this subject, published by the Labor Dept. of the British Bd. of Trade. Tabulated statistics, etc). Bul Dept of Labor-Jan. 2700 w.

†4159. Strikes in Switzerland in Recent Years (Statistics compiled from the eighth annual report of the Comite Directeur de la Fédération Ouvrière Suisse, 1894. A historical review). Bul Dept of Labor-Jan. 700 w.

†4160. Notes Concerning the Money of the United States and Other Countries. William C. Hunt (These notes contain tabulated statements of value for ready reference). Bul Dept of Labor-Jan. 2000 w.

†4161. The Wealth and Receipts and Expenses of the United States. William M. Steuart (The true value is what would be deemed a fair selling price for the property, and is thus termed in distinction from the assessed valuation. The presentation of these subjects is not designed to develop details but to show in a form for easy reference, increase and decrease in wealth, receipts and expenses). Bul Dept of Labor-Jan. 1200 w.

†4162. Decisions of Courts Affecting Labor (Review of recent decisions rendered by the supreme courts of different states, and of the United States, affecting the legal status of employers and employed). Bul Dept of Labor-Jan. 13000 w.

†4163. Extract Relating to Labor from the New Constitution of Utah (Sections 1 to 7 inclusive). Bul Dept of Labor-Jan. 400 w.

†4164. Exports Declared for the United States (Quarter ending Sept. 30, 1895. The usual complete list). Con Repts-Jan. 19500 w.

*4232. Continental and English Wages (A comparison of wages in steel works). Ir & Coal Trs Rev-Feb. 7. 700 w.

†4280. The Diversity of Banking Systems (Review of reports on this subject collated by the Comptroller of the Currency). Banker's Mag-Feb. 600 w.

†4281. Edward Atkinson's Elastic Currency Scheme (Criticism of this scheme. The ground is taken that the issuance of the certificates of deposit proposed by Mr. Atkinson, and which he thinks might take the place of bank notes and legal tender notes, at least to some extent, would be an evasion of the law and therefore an impracticable scheme). Banker's Mag-Feb. 1000 w.

†4282. A Study of National Finances (Editorial review of a scheme proposed by M. D. Kenyon, Supt. of the Banks of the State of Minnesota, which is novel and which it is thought will command attention. The proposition is that Congress should enact a law constituting the greenbacks an interest-bearing debt, which, he believes, would result in locking them up as bank reserves, even if the interest should be no higher than one per cent.). Banker's Mag-Feb. 600 w.

†4283. Description of State Banking Systems (Compiled from the Annual Report of the Comptroller of the Currency, and including the systems of Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, and Oregon). Banker's Mag-Feb. 2500 w.

†4284 Reasonable Patriotism. Earl of Meath (An inquiry whether the efforts made by the British State and nation to improve the lot of the toiling masses has increased the contentment, or elevated the condition of these masses as much as should reasonably have been expected. The answer is that no other country can show so good a record, and that the present status of labor is better in England than in other countries, not excepting the United States). Nineteenth Cent-Feb. 11500 w.

*4292. Naval Contracts for the Thames (An able editorial. An endeavor by means of public agitation to get the British government to give more contracts to the Thames ship-yards has given rise to a debate, herein reviewed, which covers nearly all of the relations of employers and employed, and the question of government control of the economics of labor. The situation as herein portrayed is very interesting as a sociological study). Engng-Feb. 7. 3600 w.

*4373. A Successful Experiment for the Maintenance of Self-Respecting Manhood. B. O. Flower (History and successful results of the plan devised by Mayor H. S. Pingree, of Detroit, Mich., to assist needy but industrious citizens by giving them free use of unimproved and uncultivated lands within the city limits). Arena-March. 2500 w.

*4374. The Human Problem According to Law. Abby Morton Diaz (The cause of our social disorder is found in law-breaking of

various kinds, natural, civil and ethical—the penalties of which violation are disorder, oppression, repression, fierce competition, rivalry, dishonor, corruption, injustice and unlimited self-seeking. From this point of view the remedy is obvious—"law keeping") Arena-March. 2700 w.

*4375. Wealth Production and Consumption by the Nation. George B. Waldron (The purpose of this article is (1) to measure the annual production of the United States; (2) to distribute this production among the families of the nation according to their probable income; (3) to show the final disposition of the total product, and thus to open a way for the measure of the congestion of wealth, which is a social feature of the time). Arena-March. 3000 w.

4376. Increase of Cotton Mills (Editorial. The great increase in the number of spindles in cotton manufacturing during the past year having given rise to a doubt that the business may have been overdone, the article attempts, with some success, to demonstrate that cotton manufacturing has not been overdone, that there is no present danger that it will be, and that it is yet a favorable and inviting field for investment). Bos Jour of Com-Feb 22. 1200 w.

4379 The Foreign View of the Loan (An editorial compilation of views, expressed in the British and European press, relative to the recent bond issue of the United States government). Bradstreet's-Feb. 22. 1100 w.

4380. Excluding Illiterate Immigrants (Editorial advocating restrictions of immigration by educational qualifications for eligibility). Bradstreet's-Feb. 22. 600 w.

4381. British Foreign Trade and Our Share in It (That the United Kingdom has entered upon a period of renewed prosperity, and that the relations of the commerce of the United States to British commerce are such that American commerce must share in this prosperity, appears to be the opinions set forth in this editorial). Bradstreet's-Feb. 22. 900 w.

*4456. The Industrial Condition of the South after 1860. Richard H. Edmonds (Tracing the progress of the South from the Civil War, which left it in poverty and woe, to the present. Its decline, followed by surprising growth since 1880. A brief statement of its natural resources and wealth-creating possibilities). Chau-March. 4500 w.

4467. The Labor Question. R. A. Hadfield (Expresses the belief that piece-work, in many cases, does not possess advantages attributed to the system; and this is followed by an argument for the daily wage system. Incidentally an account of an organization called the Industrial Union is given). Foundry-Feb. 2800 w.

*4468. The Importation of Foreign Prison Made Goods (Report of a departmental committee of the British board of trade. After a thorough investigation of the extent to which goods made in foreign prisons are imported into the British markets, the committee find them so unimportant that no steps toward their restriction are required, and that any action of this kind would produce more harm than good). Bd of Tr Jour-Feb. 1200 w.

*4471. Tariff Changes and Customs Regulations (These changes are noted as nearly to date of publication—Feb., 1896—as practicable). Bd of Tr Jour-Feb. 1600 w.

4492.—$1. The Multiple Money Standard. J. A. Smith (Topics discussed in this paper are (1) the relation of money to industrial society; (2) two conceptions of a standard value; (3) gold as an unstable commodity; (4) a composite gold and silver standard; (5) the tabular standard; (6) the multiple money standard; (7) the circulating medium; (8) a national vs. an international standard of value; (9) the multiple standard and the economic problem of distribution. The socialists are declared to be right in claiming that the crucial test of normal distribution is the maintenance of an efficient demand, but wrong in asserting that the competitive system is essentially vicious). An Am Acad-March. 20000 w.

4493.—$1. Individual Determinism and Social Science. G. Flamingo (This paper refers all social phenomena to an individual basis, and maintains that individual character is a result of the conditions of social and natural environment and hereditary environment; yet, under new conditions it reacts in an entirely mechanical manner. It also states and maintains the principle that it is impossible for a mass of population entirely "determined" in its action, to result from many individuals, relatively free, as the theories of individual free will affirm). An Am Acad-March. 4200 w.

*4500. Some Municipal Problems. E. W. Bemis (In addition to the municipal problems that have hitherto absorbed most of the energies of civic federation, this paper relates to the problem of raising and expending municipal revenues, and the attitude of the city toward monopolies of situation, such as light, heat and transportation). Forum-March. 5000 w.

†4501. Our Foreign Trade and Our Consular Service. Charles Dudley Warner (The effect upon the improvement of the consular service of the executive order of Sept. 20, 1895, is considered, and the extension of American trade as dependent upon greater efficiency in the consular service, action of manufacturers, merchants and exporters, and active interest of the government). N Amer Rev-March. 5500 w.

*4503. The Hungarian Millennial Exhibition at Budapest (An outline of what is anticipated will be a very successful exposition, in which the flour-milling industry will be one of the greatest features). Mach, Lond-Feb. 15. 900 w.

4518. Grain Going to Gulf Ports (Reviews the complaint of New York interests that this is due to enforcement of the Joint Traffic Association rates. The opinion is hazarded that some of the changes in currents of traffic are more likely to be permanent than in former years). Bradstreet's-Feb. 29. 900 w.

†4536. Cotton Mills of Japan (Tabulated statistics obtained from the Japanese consulate). Cons Rept-March. 1000 w.

4590. Farming on Vacant City Lots (Editorial discussing a pamphlet published by the New York Association for Improving the Condition of the Poor, and showing the beneficial

results from the carrying out of Mayor Pingree's idea). Gar & For–March 4. 1500 w.

4611. Pending Trade Mark Legislation (Editorial. Discusses, with approval, a pending amendment to the present U. S. trademark law, which provides for granting trademarks used in commerce among the states, and not restricting it as heretofore, to goods used in commerce with a foreign nation or some Indian tribe). Sci Am–March 7. 1400 w.

4661. Bank Clearings Increasing (Tabulated presentment of bank clearings at 87 cities for February, at 83 cities for the month and two months this year and last, and at 75 cities for four years. The table indicates an increase of bank clearings). Bradstreet's–March 7. 800 w.

4662. Comptroller Eckels on the Currency (Editorial review of recent address at the banquet of the Massachusetts Reform Club, in which the cause of the weakness of the credit of American currency is traced to the fact that since the issuance of the first treasury note, in 1862, the inflationist has been the controlling force in American monetary legislation). Bradstreet's–March 7. 900 w.

4663. British Investment Funds and Investments (Editorial comments upon the recent rise in the price of British consols, the decrease in the interest paid on these securities and the marked tendency of British investors to take a more active interest in American securities). Bradstreet's–March 7. 900 w.

4664. Present and Future of Africa's Commerce (In this article it is contended that notwithstanding the small amount of commerce in proportion to area at present carried, the turn of Africa has come, and need for her coöperation in the general economy of the world will increase). Bradstreet's–March 7. 1300 w.

†4675. Social Control. Edward Ailsworth Ross (An attempt to concisely express the characteristics of true society as distinguished from all other aggregates and combinations of men. Our first duty, it is asserted, is to search the field of rewards and punishments for the means of social control). Am Jour of Soc–March. 8000 w.

†4676. A Belated Industry. Jane Addams (An attempt is made to present this industry from the point of view of those women who are working in the household for wages. The opinions have been largely gained through experiences in a Woman's Labor Bureau and through conversations held there with women returning from the "situations" which they had voluntarily relinquished in Chicago households of all grades. These same women seldom gave up a place in a factory, although many of the factory situations involved long hours and hard work). Am Jour of Soc–March. 5800 w.

†4677. A Programme of Municipal Reform. Franklin MacVeagh (Bad city government is regarded as one of the most hopeful of modern problems in reform, from the fact that it has come to be almost fully and generally realized. General lines upon which the solution of the problem should be attempted, are laid down). Am Jour of Soc–March. 4400 w.

†4678. Scholarship and Social Agitation. Albion W. Small (The main purpose of this paper is to challenge the claims of that type of scholarship which assumes superiority because it deals only with facts, and which is regarded as obstructive in proportion to its insistence that nothing belongs in its province except demonstrative evidence. It is the present duty of scholarship to reconsider all that is involved in the existing institution of property). Am Jour of Soc–March. 6500 w.

*4679. Are We a Nation of Rascals? John F. Hume (The thesis is that instability in money always results in injustice. Whichever way it fluctuates someone is defrauded. The substitution of a fifty per cent. silver for one-hundred per cent. gold dollar, as now urged by many, would be the gigantic fraud of the century, and would make us a nation of rascals). Am Mag of Civ–March. 3800 w.

*4680. Canadian Tariff Reform. J. W. Russell (The economic unity of the North American continent is postulated, and freer trade between Canada and the United States is claimed to be the natural corollary. This corollary is held to be implied in the statement of the tariff policy advocated by Canadian liberals. That Canada will follow the United States in the direction of tariff reform is regarded as probable and reasons for this view are given. The liberals in Canada even now maintain that tariffs should not be based on the protective principle, but upon the requirements of the public service). Am Mag of Civ–March. 3500 w.

*4681. The Iron Law of Wages. Charles Drake (The iron law of wages is viewed as the result of a combination of Malthus's law of population, and Ricardo's theory of rent. Under this logical result, it has come to pass that the earth can barely support the population living upon it. To prove these propositions, theories are compared with facts, and it is concluded that both Malthus and Ricardo are wrong, and that the iron law of wages based upon these doctrines, is as false as the doctrines themselves). Am Mag of Civ–March. 1500 w.

*4682. Banking and the Currency. Lewis R. Harley (A review of the history of the currency and of banking during the nineteenth century). Am Mag of Civ–March. 5000 w.

*4683 The Problems of Charity. Robert Treat Paine (From an address before the National Conference of Charities and Correction. The true principle of business is regarded as lying between avarice on the one hand and charity on the other; and on this plane are found such organizations as working men's loan associations, the beneficent effects of which are urged and dwelt upon). Am Mag of Civ–March. 2500 w.

4705. Statistical Studies Concerning Labor Conditions. Director H. Schneider (Translation from the German, of a paper describing an investigation of the health statistics of working people, employed in gas works for a period of 32 years. The results indicate that this labor is not more unhealthy than the average of other occupations). Am Gas Lgt Jour–March 9. 1200 w.

We supply copies of these articles. See introductory.

MARINE ENGINEERING

Development of the Japanese Mercantile Marine.

THE following abstract of correspondence in *Engineering* (London, Jan. 31) indicates the progress of the Japanese in marine construction.

"The Japanese mercantile marine has only been in existence for a little over a quarter of a century. At the end of 1870 the total number of ships of European form, both steam and sailing, was 46, with an aggregate registered tonnage of 17,952 tons."

A table giving the rates of tonnage of Japanese and foreign vessels shows that 18.6 per cent. has been carried in Japanese ships, and another table shows that the freight earnings of Japanese ships have been 1.3 per cent. of the total. This discrepancy between the earnings and the increase in tonnage of the Japanese vessels having attracted the attention of the Tokyo chamber of commerce, a discussion of the subject was followed by a memorial to the ministers of State for finance, agriculture, and commerce. Communications were made, containing some very important proposals, which at least show that the Japanese are ambitious of taking a leading position among the mercantile nations of the world.

In order to indicate the extent of that ambition, we have only to mention that the memorialists dilate on the importance of extending the steam service of Japan to America, Europe, Australia, and other foreign parts. Seven such lines are mentioned. First, the Tientsin line, to connect Japan with the ports of Korea and North China; it is proposed to open this as a mail line, with one vessel every week. Secondly, the Shanghai line, which is also to be a weekly mail service. Thirdly, the Vladivostock line, the vessels of which would touch Korean ports, *en route*; also a mail line with weekly service. Fourthly, the China sea line, touching at ports in South China, and extending as far as Tonkin, Saigon, and Siam. This is to be a mail line with fortnightly services. Fifthly, the European line connecting Japan and London or Liverpool. This it is proposed to open gradually, the first step being to convert the Nippon Yusen Kaisha's present Bombay service into a mail line, and to arrange that the company shall establish a periodical freight service to Europe by way of trial. Sixthly, the American line. This, it is suggested, should be run as a mail service at least once per month, by large steamers capable of being converted into cruisers in time of war. Seventhly, and lastly, the Australian line. This is to have either Melbourne or Adelaide as its objective point, and its immediate opening as a monthly line is recommended. It is proposed that each of these lines should be subsidized; the memorialists do not enter into the details of this part of the subject, but leave the matter to the authorities, merely observing that the allowance must necessarily vary according to the articles of contract.

No doubt this very extensive programme will be received with a smile by those who know the difficulties involved in carrying it out, but the correspondent of *Engineering* says the doubters may rest assured that the Japanese will ultimately succeed. As with all their other projects, they have carefully thought out the details, and, while developing the practical part of the work as rapidly as circumstances will allow, they have resolved that it shall have a solid foundation by making increased provision for the education of officers and the training of common sailors. Concerning the education of officers, the memorialists recommended enlargement of the commercial navigation school at Tokyo, and that arrangements be made for complete courses of instruction in navigation and engineering. To make the instruction of the school thoroughly practical, it is suggested that training ships should be attached to it, so that the student may

make voyages to different parts and gain experience in navigation.

Provision for the training of common soldiers, and State subsidies to ship-builders, are recommended. That the subsidized ship-yards shall be favored with orders for the construction of war-ships is part of the programme. The details of the scheme of State subsidies show a determination to assist and encourage the industry in every possible way.

The "Evoy" Jumper-Stay Compass.

THIS new marine compass rig is described in *The Marine Engineer* (Dec. 1), and it appears to be a very ingenious as well as meritorious improvement. It is stated that it has already gone into use on important vessels, among which are named the American liners, St. Louis and Paris; four vessels of the General Steam Navigation Company; the entire fleet of the Nautilus Company, of Sunderland; the Union R. M. S. Tartar; the City of Vienna, of the city line of Glasgow; and many other vessels, including yachts. Some of the masters of these vessels are said to speak very highly of the improvement, which is a "spirit compass" so designed and constructed as to allow of its being hoisted sufficiently high aloft to place it quite beyond the range of any local or induced magnetic lines of force due to the metallic construction of the vessel or its cargo, the mechanism being so arranged as to insure that, while the card swings absolutely free of all inductive influence when aloft, the first effort to haul the compass down instantly locks the card in place. As the card is not again freed, the correct reading so obtained is brought down to the bridge, or deck level, when comparison with, and correction of, the ordinary steering compass is readily and accurately made." The fanciful name, 'Evoy," is a contraction of the nautical phrase "heave ahoy." The engravings, Figs. 1 and 2, clearly illustrate the device.

"A jumper-stay running fore and aft from topgallant-mast-head to topgallant-mast-head has tackle rove from it, and secured to the deck in the manner shown. In its normal position the compass is down and locked, as in Fig. 1. When it is desired to take a reading, the card is unlocked by pulling back a trigger on the fore side of the bowl, and the cross frame containing the compass run aloft, as shown in Fig. 2. About three minutes suffice for the card to take up its correct magnetic position, after which the vessel is kept steady on her course, and, if rolling, a moment is selected when she is upright to haul the compass down to the bridge.

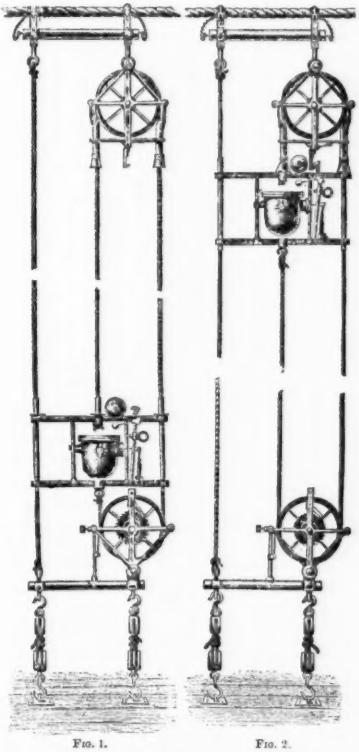


FIG. 1. FIG. 2.

"The first pull of the hauling-down motion automatically liberates the internal locking gear, thereby clamping the card in its then position, and simultaneously causes the bell to ring aloft. The reading of the overhead compass, when so clamped and hauled down, is then compared with that which the standard steering compass showed at the moment the bell rang, and the difference, if any, is the deviation of

the latter compass correctly ascertained apart from the aid of sun, moon, or stars, and as readily and accurately obtained during thick or foggy weather as in the brightest light.

"The use of this compass ensures, amongst others, the following advantages: a correct magnetic course is always ascertainable, regardless of the state of the weather or even during a dark night, and apart from azimuths, bearings, or calculations of any kind; as the compass is entirely removed from all metallic influence, there can be no deviation; the compass is correct in any latitude; a direct reading is taken on bridge or deck, without the aid of any only too frequently moisture-dulled glasses or reflectors; it is less expensive and more reliable than pole or masthead compasses, which in several lines of steamers it has superseded."

How to Fit Liners to Shafts.

THE danger of trusting wholly to the method of shrinking liners on shafts is well illustrated in the following narrative extracted from *Engineers' Gazette* for February. The narrative also illustrates the nature of many emergencies at sea which engineers are called to meet, as well as the readiness most engineers display in inventing remedies for temporary disabilities, when circumstances demand the exercise of this sort of talent.

A steam-ship, not named, recently sailed from Odessa for Copenhagen, but, after two days' bad weather in the Black sea, about an inch of water was discovered in the shaft tunnel near the engine room,—a place that had hitherto been perfectly dry. We will present the story of what followed in the narrator's own language.

"The chief sent the second engineer along the tunnel to the stern gland to try and ascertain the cause, and found the forward brass sleeve on the tail end shaft had become loose on the shaft, and had worked its way along a distance of six feet into the tunnel, against the aftermost shaft bearing, so that there was a rush of water into the tunnel corresponding with the space formerly occupied by the liner. The donkey pump was at once started on the aft-well, but the rush of water was found to be too great for the donkey to keep the well clear, although pumping full bore. The captain had been informed, and he sent ashore for a diver. By this time there were now four inches of water in the tunnel. The engineers collected a sack-full of hatch wedges, also two large quarter hammers, and went along to the stern gland and found water rushing in worse than before, the water being now about six inches deep. The wedges were driven in as close as possible to one another right round the shaft, and between the tail end shaft and the inside of the gland. At first great difficulty was experienced in getting the wedges to hold, on account of the force of water coming through the gland, but, after many attempts and failures, the wedges were firmly driven in right round the shaft. This stopped the flow of water, the donkey being now able to pump both the aft-well and the tunnel quite dry. The diver had just arrived, and, to make the job more secure, went down to the outer end of the stern tube and fixed some patent cement round the shaft and the end of the tube to keep the force of water out of the stern tube, thereby reducing the risk of the wedges being forced out into the tunnel. It may be mentioned that, after successfully stopping the water (which occupied two hours, during which time the engineers were working up to their waists in water, with hardly a scrap of clothing on), the engineer had to crawl along the tunnel shafting to get back into the engine-room again, the water being three inches below the top of the tunnel shafting. Next morning the ship was towed into Constantinople. During the night the engineers kept strict watch along the tunnel, the stern gland being visited every twenty minutes. On arrival in port, the after holds were discharged to tip the propeller out of water. Then, after removing the wedges, slipping the gland back, and drawing all the packing out of the stern gland, the liner was replaced, not in the exact original position, but projecting past the flange of the stern gland a distance of eight inches into the tunnel. This was done to allow of ⅜-inch tap holes being drilled through the liner,

and about one inch deep into the shaft. Four of these holes were drilled at equal distances around the shaft at the foremost end of the liner, and the other two holes were five inches aft of the other four holes near the gland itself, screwed brass plugs being inserted and riveted over. This was considered sufficiently strong to hold the brass sleeve in its place. On arrival home, two new liners were fixed in the tail end shaft. On examination of the shaft, it was found that the original liners had not been contracted and then pinned on, but merely contracted on, which, in my opinion, should not be allowed. The stern gland and tunnel had been inspected on watch five minutes before the water was first discovered in the tunnel, and found to be running quite cool. The only reason for the liner coming loose appears to be that the shaft must have been a slack fit in the stern tube to commence with, and, during the heavy weather that was encountered, the shaft had been thumping in the tube, and so hammered the liner into the form of an oval. The subsequent working ahead and astern into Constantinople had helped, as it were, to screw the liner along the shaft, assisted by the force of water in the stern tube."

The Holland Submarine Boat.

ENGINEERING NEWS (March 12) quotes from the Baltimore *News* a description of this boat now under construction at the Columbian Iron Works of that city. The dimensions of the craft are as follows: Length, 80 ft.; maximum diameter, 11 ft.; displacement at surface, 118.5 tons, and totally submerged, 138. tons. The contract conditions require her, when running at full speed on the surface, to dive to a depth of 20 ft. within one minute after giving the order, and automatic apparatus prevents her from sinking below a fixed depth. The frame is made of angles 20 ins. apart, covered with ⅜-in. steel, with ½-in. steel armor plate on the top surface. For three-quarters of her length the shell is double, with the space between used for coal bunkers and water-ballast, and separated by water-tight bulkheads. Inside the shell, bulkheads of ¼-in. plate divide the vessel into seven compartments. Triple expansion engines will propel twin screws; coal will be used for fuel when running at the surface, and electric power when the boat is submerged. She will be provided with horizontal as well as vertical rudders and a vertical screw will assist her in descending. The contract speed is 15 knots per hour at the surface, with only her superstructure visible; with 3 ft. of water over the hull the speed is to be 14 knots, and 8 knots when completely submerged. Air compressed to 200 lbs. per sq. in. will supply the crew of 6 or 8 men when the boat is beneath the surface and the electric storage battery will supply light. The capacity of the storage battery is sufficient for a 6-hour run at 8 knots speed beneath the surface. All that appears above the upper surface of the boat is a small armored turret, and a smoke-stack. The contract price of this invention of Mr. John V. Holland is 150,000 dollars.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Marine and Engineering Journals—See Introductory.

*4091. On "Comparison of Mechanical Draughts." John Thom (A paper read before the Inst. of Engs. and Shipbuilders in Scotland. Recounts observations made during voyages in ships each using a different system of mechanical draught with conclusions arrived at. The four systems discussed and compared are (1) the Howden system, (2) the British admiralty system, (3) the Ellis and Eaves system, and (4) the closed ash pit system. The paper is based upon careful notes taken during these voyages). Eng's Gaz-Feb. 4000 w.

*4092. A Loose Liner on a Tail End Shaft. Mac Hine (Illustrates a danger that may arise when liners are merely shrunk on and not also attached by pins). Eng's Gaz-Feb. 800 w.

*4093. Countersinking in the Shipyard. Robert H. Muir (Read before the North-East Inst. of Engs. & Shipbuilders. A detail which has received less attention in the ship-yard than almost any other. The object of the paper is to draw out information, and to arrive, if possible, at some agreement upon a correct angle of countersink for different sizes of rivets and thickness of plates used in ship-yard work). Eng's Gaz-Feb. 1300 w.

*4094. The D'Allest Water Tube Boilers

(Comparative tests of new and old style D'Allest boilers. The description of the tests is by Mr. D'Allest). Eng's Gaz-Feb. 1100 w.

*4103 Sir E. J. Reed on the Question of Ship's Side-Lights (Defence of an order of the Marine Department of the Board of Trade, issued Jan., 1893, prescribing an angle of four degrees as the largest at which any part of a ship's side light should pass the screen and cross the line of the ship's advance The severe criticisms to which this order has been subjected are answered). Steamship-Feb. 1700 w.

*4105. Transatlantic Passenger Traffic (Editorial. Review of official returns for 1895). Engng-Jan. 31. 800 w.

*4107. The Development of the Japanese Mercantile Marine (Interesting correspondence portraying the remarkable development of the shipping interest. No less than seven new lines are now talked of. The system of State subsidies is recommended by the Tokyo chamber of commerce). Engng-Jan. 31. 1800 w.

*4108. French Shipping Bounties (Unsatisfactory increase in the number of French commercial steamers, notwithstanding the government pays more in bounties than any other country. Editorial). Engng-Jan. 31. 1100 w.

4144. Water-Tube Boilers. Ill. W. T. Bonner (Paper read before the Mining Assn. of Quebec. Setting forth facts which the writer believes to be proof of the correctness of the system). Can Elec News-Feb. 4200 w.

*4298. Patent Marine Salvage Appliances (Illustrated description of a variety of modern appliances for raising sunken vessels and recovering submerged cargoes, with methods of using the same). Marine Eng-Feb. 1. 1100 w.

*4306. A Practical Formula for Thrust Bearings. J. Husband (This formula is based upon the assumption that the whole area of the collars on the screw shaft is not in contact with the bearing surface. The investigation from which the formula is derived is also presented). Prac Eng-Feb. 7. 200 w.

*4386. Calculation of Horse-Power for Marine Propulsion. Thomas English (The calculation proceeds from the basis of the resistance of a given vessel at the speed desired. Froude's method of ascertaining resistance is approved and adopted, as is also the principle that according to Froude's method it will always be possible to make two models on such scales that the same absolute speed will for one of the models, correspond with that of a ship which has been tried at sea, and the other with that desired for a proposed ship. An apparatus whereby the delicate dynamometrical apparatus ordinarily used with a model tank may be dispensed with. The mode of using it is also described). Ind & Ir-Feb. 14. 1300 w.

4397.—$1.25. Contract and Screw Trials of the U. S. S. Katahdin. F. C. Bieg (An exhaustive description with numerous illustrations of machinery, etc., and tabulated data derived from the tests). Jour Am Soc of Nav Engs-Feb. 5000 w.

4398.—$1.25. Contract Trial of the Machinery of the Texas. T. W. Kinkaid (Complete description with numerous illustrations of machinery, etc., and tabulated data resulting from the tests). Jour Am Soc of Nav Engs-Feb. 3300 w.

4399 —$1.25. Test of a No. 4, Type B (Horizontal) Evaporator. G. W. Baird (Illustrated description of tests of an evaporator of the kind named, designed for the Nashville, U. S. N). Jour Am Soc of Nav Engs-Feb. 700 w.

*4412. Salvage Tug for the French Navy (Illustrated detailed description). Engng-Feb. 14. 800 w.

*4413. The Training of French Naval Officers (Editorial. Historical sketch from the initiation of the project, to its final adoption, and its general value to French marine progress, with an outline of the scheme of training it will offer). Engng-Feb. 14. 2500 w.

*4416. Telemeters and Range-Finders. Profs. Barr and Stroud (Paper read before the Inst. of Mech. Engs. Confined to a description of the range finder now used in the navies of Britain and other countries, and to another smaller hand instrument which is much more portable and much simpler than the former, the object apparently being to exploit the latter). Engng-Feb. 14. Serial. 1st part. 3500 w.

*4552. Engines of Torpedo Boat Destroyers "Handy," "Hart," and "Hunter" (Illustrated detailed description). Engng-Feb. 21. 1100 w.

*4554. Water-Tube Boilers for the Dutch Navy (Illustrated description and an account of tests). Engng-Feb. 21. 1200 w.

†4577. The Marsden Corn Pith Cellulose. Lewis Nixon (A simple explanation of some of the phenomena connected with the behavior of vessels under various conditions, is followed by a discussion of the use of cellulose as a water excluder in armored vessels as related to buoyancy and stability of vessels at sea). Jour Fr Inst-March. 3300 w.

*4686. Rates of Speed and Rates of Freight (Their relation is ably considered. The limit of 19¼ knots, with 7 days limit of time for remaining in port is fixed as the speed for maximum profit, for a ship of 10000 tons burden. Above this speed profits rapidly diminish). Eng, Lond-Feb. 28. 2800 w.

*4688. Lengthening the Cape Mail Steamer Scot (Describes the lengthening of a steamer by an addition of 50 ft. The vessel is cut in two and the addition to length is made amidships. Illustrated by diagrams showing the method). Eng, Lond-Feb. 28. 300 w.

*4689. Modern Warships and Dock Entrances (Descriptive, with engravings showing the widest and the least, of the existing and proposed entrances). Eng, Lond-Feb. 28. 1000 w.

*4692. Boiler and Engines of the "Santo Antonio" (Illustrated detailed description). Engng-Feb. 28. 1400 w.

*4710. Quadruple Expansion Engines for Lake Service. Walter Miller (Economy secured by the adoption of high steam pressures, and quadruple expansion on the lake marine since 1855. Discussion). Jour Assn of Engng Soc-Jan. 6000 w.

MECHANICAL ENGINEERING

High Admission Requirements in Engineering Schools.

AN editorial in *American Machinist* (Feb. 13) criticises the modern tendency to increase the standard of requirements for admission to engineering schools. This is regarded as the most unfortunate development of the educational system in these schools, and it is objected to on the following grounds.

"High admission requirements are supposed to test the ability of the applicants, and to sift out those who are least capable of pursuing the course of study with profit. In point of fact, they do nothing of the kind. Instead of testing the abilities of the student, their real effect is to test his opportunities, and to sift out those who, by reason of location, occupation, or lack of means, have been denied access to the best preparatory schools. We do not for a moment imagine this to be their object, but it is undoubtedly their effect. The result is a new illustration that 'to him that hath shall be given, and from him that hath not shall be taken even that which he hath.'

"The usual explanation of their course by engineering faculties is that the high requirements are necessary to keep down the number of applicants which otherwise overwhelm the schools. Most of the schools admit the necessity for shop experience by providing it in their school work. Now, if it is desired to keep down the number of applicants, how would it do to require them to have served an apprenticeship in a machine shop? We do not doubt this would be still more effective than the present plan with a large number of the present class of applicants. Or, if this is considered too revolutionary, what is to prevent an arrangement by which previous shop experience should offset some of the more advanced of the present requirements,—the time which the present class of students devote to shop work being given by the new class to the preparatory studies in which they would be deficient?

"In the old days, it was possible for one who had spent considerable time in the shops to still pass the then comparatively modest examinations for admission; and a good proportion of the students were of this class. If Professor Sweet (the most successful instructor, in proportion to his opportunities, that the engineering schools have seen) were asked, we do not doubt that he would testify that such students formed the very best timber he ever had, whereof to make engineers.

"It should be noted that the course suggested would assist in solving that other and still greater problem,—in fact, greatest problem in education, and one which we have always with us,—namely, self-support by poor students. A student in possession of a trade on entering college could use his vacations profitably in providing himself with funds; and the policy outlined, if adopted, would give heart to many who can now see no means of educating themselves.

"It will be objected, of course, that the plan proposed would interfere with the curriculum, and introduce confusion in place of order. The average college professor is, of course, a worshipper of system as system; but the man of affairs knows that a system which interferes with results is, in fact, mere red tape, and should be treated with corresponding contempt.

"A conspicuous illustration of our remarks is Cornell University, whose founder gave not only his fortune, but his life, in the belief that he was founding an institution for the benefit of the class from which he himself came, and for which we are here pleading. Moreover, this institution is largely endowed with public funds, which would seem to increase its obligations to the general public. The entrance examinations could not be better planned if they were intended to exclude students from the shops, and, so far from the found-

er's plans being carried out, they have, in fact, been seemingly forgotten. Cornell University to-day does little more than duplicate facilities for education which exist in ample degree without it. It is naturally becoming more and more a school for the education of rich men's sons; and testimony is not lacking that a spirit of aristocracy is springing up among its students, in place of the old spirit which illustrated democracy at its best. Meanwhile it aspires to the position of a State University, the recognized head of the State system of instruction, and asks for more public money. Is it surprising that it does not get it?"

The force of the arguments we have quoted can not be denied. We should like to see a competition between two engineering schools,—one requiring shop practice as a qualification which, with other qualifications attainable by ambitious boys who work in shops, should be sufficient for matriculation, and the other requiring the qualifications now demanded for admission to either Cornell or Lehigh University,—so that the merits of the two systems could be tested by the results shown in the active lives and achievements of the graduates of the two institutions respectively. We have little doubt that in the end the former would demonstrate its superiority.

It is only fair to add that the statements made by *American Machinist* with reference to Cornell University were met with a courteous denial from Professor R. H. Thurston, printed in the same paper (March 5). A review of Professor Thurston's communication is reserved for our May number.

Reamers Without Clearance.

AN accomplished American mechanical engineer, Mr. T. R. Almond, of Brooklyn, N. Y., writes to *American Machinist* (Feb. 20) on the subject of reamers without clearance, describing a practical method of making such a reamer and one that can be kept sharp without altering its diameter at the cutting edges. As this subject is of importance in mechanical construction, we gladly aid in disseminating the information thus presented.

After specifying the importance, in much mechanical construction, of limiting variations to those no greater than one-quarter of one-thousandth of an inch, of the production of holes that vary in size no more than a fraction of an inch named, and of the advantages resulting (economical production and interchangeability) from such a degree of accuracy, he premises that, after having fixed upon the sizes of holes, a good gage and a good reamer will be needed to get these sizes, and he gives directions for making both implements.

"The first thing necessary is to fix upon the size of the hole best suited to the purpose, so as to avoid future changes. You will then be warranted in making a standard, hardened and ground steel plug-gage of the size required. If this were for my own use, and the size of hole required were $1\frac{5}{8}$ inch, the plug I would make 8 inches long,—4 inches for ground part at one end, $2\frac{1}{2}$ inches of somewhat reduced diameter between the ground and knurled ends, where name, size in thousandths, and other matter required, would be stamped before hardening. Having one such gage, you will not perhaps require another of same size in a lifetime, the amount of wear being practically nothing.

"The reamer is the next thing of importance, and decidedly the most interesting. The possession of the two virtues, faith and hope, may be required to enable you to put an ordinary straight-fluted jobber's reamer into shape for the purpose. Assuming the size required to be $1\frac{5}{8}$ inch, the reamer to be found on the market is of no use, unless perhaps you should have the good fortune to have one about .010 above size. This should be ground to the required size in lathe or universal grinding machine, as you would grind any cylindrical piece of work, great care being taken to let the wheel cut very little as you approach the required size. When finished, each tooth will be cylindrical in shape, back of the cutting edge. After the cutting edges have become dull by use, they may be sharpened by careful grinding on the face of the tooth. This can be done by hand, if the wheel be true, the hand steady,

and the grip taken well towards the back end or shank part of the reamer, the face of the tooth being applied to the under side of the wheel of an ordinary every-day emery-wheel stand. A little practice will be required to do this nicely, and it is well worth the trouble, as in this way many dull reamers may be sharpened without changing their size.

"The manufacturers of reamers usually bring the teeth up to a sharp edge, leaving no cylindrical portion back of the edge. This, for cast iron, is a mistake, as the edges soon become worn and lose their size. It is true that such reamers will cut more freely; but, as absolute size is the thing desired, they answer for a short time only. I have had a reamer in use for several years, which makes a hole so close to the gage that a slight difference of temperature—say 20 degrees—between it and the work is quite appreciable in the fit. This reamer has been used on a good quality of cast iron only, and not allowed to come in contact with scale.

"The holes are first bored to size, leaving but two or three thousandths for the reamer to take out. Tools of this description should be made of the very best quality of steel, and left as hard as possible. After being hardened, they should be heated to a degree just short of showing any color. This should be done before the tool is ground. If done after the grinding process, it will, in all probability, no longer be true. In other words, a piece of good tool steel, made as hard as possible and then ground true on centers, will, in all probability, upon being reheated to 300 or 400 degrees, change its shape or become out of true."

Aluminum Alloys to Replace Brass.

MACHINERY for February quotes from the *Aluminum World* a description of new aluminum alloys, which, it is claimed, may replace brass in castings, and which are made by directly reducing the metals in reducing pots, with special precautions against oxidizing and occlusion of gases The new metal, if in all respects as described, has promise. We quote enough of this description to show what is claimed.

"The alloys have a specific gravity of between 3.0 and 3.15, where brass has a specific gravity of from 8.21 to 8.44; the brasses being 2.57 to 2.70 times heavier than the aluminum alloys. These alloys contain a larger proportion of aluminum than the brasses do of copper; and, when the selling price of the brass ingot is multiplied by its factor of relative weight, the aluminum alloy is now being sold at as low, and in some cases at a lower price, bulk for bulk. This means a great deal, not only in the utilization of aluminum in the arts, but in the application of a vast number of the engineers' constructions, and warrants the careful study of the relative merits of the two sets of alloys. The aluminum special casting alloys which now sell in ton lots of ingots at from twenty to twenty-seven cents per pound, according to quality, are relatively cheaper for the manufacture of casting than the brass now in general use for this purpose. In a general way, their composition is from seventy to seventy-five per cent. of pure aluminum, together with zinc, copper, nickel, manganese, iron, and, in some cases, with titanium, chromium, or tungsten. These alloys have as little shrinkage as ordinary brass, and can be re-melted in plumbago crucibles and cast with the same facility as can brass, and are now becoming largely used in the leading brass foundries of the country.

"The bronzes, under which name are included the principal alloys of copper and tin, together with a few special compositions such as phosphor-bronze, aluminum bronze, manganese bronze, etc., are all higher in cost of manufacture than the brasses, and are now more expensive than the cheap special casting alloys of aluminum, and are at least equal in expense with the nickel and copper-hardened alloys which contain ninety per cent., and more, of aluminum. The cheapest of the bronzes, containing from one to even as high as ten per cent. of zinc, and with small percentages of lead and iron, cost at least twelve cents per pound and range as high as fifteen cents per pound in ingots. These alloys have a tensile strength of from 46,000 pounds to 50,000 pounds per square inch, in hard-rolled sheets. In castings, brass

has a tensile strength of from 18,000 to 30,000 pounds per square inch, with an elastic ratio of from twenty-five to thirty-five per cent. The hardened aluminum alloys compare favorably in tensile compression and transverse strength with brass alloys. The special hard casting alloys containing over seventy per cent. of aluminum and having a specific gravity of 3.15 are furnished by the Pittsburg Reduction Co., with a guaranteed tensile strength of from 25,000 to 30,000 pounds per square inch, and with an elastic ratio of over forty per cent."

Books on Steam Engineering.

AN editorial on this subject (*The Electrician*, Feb. 21) treats of what it styles a *renaissance* of superheating in steam practice, and expresses the view that, notwithstanding there are disadvantages which weigh more or less against its advantages, the former "are not so formidable at the present day as they were in earlier times." At the same time it is noted that neither pressure of steam or the extent of the superheating in former years ever nearly approached the practice of the present day in these particulars. The introduction of mineral oils which have replaced animal and vegetable oils and fats for engine lubrication has had much to do with lessening the troubles that once attended superheating. It is concluded that "we are on the eve of a very considerable extension of the use of superheaters in steam-engine practice." This increased use of superheaters follows naturally upon the growing use of water-tube boilers.

A new work on steam engineering,* written by an ex-president of the International Society of Mechanical Engineers (who is said to have been a former supervising inspector of steam vessels for thirteen years), having recently come to our desk, an examination of this book for the latest information upon superheating naturally suggested itself to us on reading the editorial referred to. In a large octavo volume of 803 pages, with such a title as "Library of Steam Engineering," one would expect to find something relative to superheating, which dates back to Trevithick's time, and something also relative to water-tube boilers, which have been in successful use on land for more than two decades, and have also been used for marine purposes with such success that their increased future use for marine propulsion is certain. The book has a table of contents for each chapter and an index. We have vainly sought by these aids to find anything relating to superheaters, or to water-tube boilers. "Tubulous boiler" is also a term much used to distinguish water-tube boilers from fire-tube boilers, but it is not in the index of this book. Seeking an explanation for these omissions in the preface or introduction, we confess to surprise at finding in the first sentence of the preface that "the aim of the author has been to produce a book that would embrace the entire field of the science of steam engineering." In the second paragraph of the preface it is stated that the further purpose of the author has been "to embrace, in the same volume, all the information necessary to enable engineers to pass a most successful and rigid examination by inspection officers; to enable engineers to fill positions of inspectors; to become experts in making evaporative and calorimeter boiler tests, and indicating steam engines; adjusting valves and valve-gear, and draughting plans and specifications for the construction of steam-boilers; in short, to become proficient in all the arts and sciences (?) of steam engineering, stationary, locomotive, and marine." We submit that these assertions entitle us to look with confidence to the text of the work for something relating to any appliance more or less used in steam practice for periods of from say twenty to fifty years. Somewhat discouraged, we looked in the chapter on calorimeter tests, thinking something might be found about superheating (upon which accessible literature is quite abundant), and we did find the following sentence.

"If the steam is super-heated, it will show a greater number of heat units per pound for a given pressure than is con-

* A LIBRARY OF STEAM ENGINEERING. By John Fehrenbach, M. E. The Ohio Valley Co. Cincinnati, 1895.

tained in the standard steam as shown in the table." This is all we could find about superheating in the entire book. The list of engravings is a long one, and is not alphabetically or systematically arranged; but we groped through it, hoping that we could there find some reference to superheaters, or water-tube boilers, or both. We found none, and so are constrained to say that our first attempt to use the book was very disappointing. However, any one who has tried to become familiar with the general run of books annually added to the literature of steam engineering has probably had many similar experiences. In many cases this is not because the books do not cover some part of the ground sufficiently well, but rather because what is claimed for them in title-pages, prefaces, and introductions is more than the contents will justify. And there are many books on steam engineering which seem to have been issued simply because their publishers wanted books of this kind to sell. It is easy to make a book where the work involves little labor beyond that of compilation; but to make a *really good* book—one that shall prove a valuable addition to the already large list of good books on steam engineering—requires more than skilful compilation from pre-existing books. Some books of this kind come under our notice which contain absolutely nothing not found in much better form in other books always contained in any library of steam engineering literature, even if it be a small one. Why are such books published and advertised? They are merely "made to sell."

At Last—Actual Flight by Human Kind.

HUMAN flight is at last a feat accomplished. To be sure, the beginning is a clumsy, imperfect flight, ridiculously imperfect as compared with the flight of the pigeon, the swift, or of the heavier birds, like wild geese or ducks that move far over our heads toward southern feeding grounds, where they are eagerly sought by presidential sportsmen; but *it is flight*, actual, though as yet not very far removed from the mere potential.

A writer in *Nature* (Jan. 30) says that Herr Otto Lilienthal's experiments have, up to the present, shown that, by means of such apparatus as he employs, fairly long flights may be indulged with perfect safety, provided the operator does not attempt to do too much at the beginning, but contents himself with mastering the first elements of sustaining his equilibrium. The following abstract of the article gives a fairly good representation of the situation.

Falls must be expected in preliminary trials, until the operator becomes accustomed to the many new conditions, and before he learns to master them instinctively and automatically. In other words, it requires considerable practice to fly with the Lilienthal apparatus.

For instance, similar difficulties have to be contended with when learning to ride a bicycle. The beginner is at first unable to keep his equilibrium, and so wobbles here and there with the loss of much power, until he eventually finds himself on the ground. This is simply because he is doing something unusual, and is not accustomed to the new conditions. An adept rider, on the other hand, never thinks of the possibility of falling, and quite unconsciously keeps his equilibrium without any exertion or loss of power. So it is with this sailing machine, and it is only with practice that the required head can be obtained and success assured.

The experiments have been extended to a new form of machine, employing what is claimed to be a new principle. The idea consisted in using, instead of one large framework covered with some light material, two smaller ones, placed parallel, one above the other. These, of course, would, when sailing through the air, have a similar lifting effect; but, besides affording a simple means of increasing the sailing area without adding to the breadth of the machine, they would decrease very considerably the difficulties, referred to above, with respect to the management of the center of gravity.

On this principle Otto Lilienthal constructed his new double apparatus. Each separate surface has an area of nine square meters; thus it is possible to employ the

very large carrying surface of eighteen square meters with a breadth of only five and a half meters. The upper surface, which is placed at a distance of about three quarters of a wing-breadth above the lower, proves in no way a disturbing factor in the machine, as might at first be supposed, but develops simply a vertical lifting force. It may be remarked that this double-surface machine is managed in exactly the same way as the single-framed one. The upper surface is fixed rigidly to the lower one by means of two rigid stays, the whole surface being held in position by means of thin wires.

With the new apparatus, Otto Lilienthal has already found that a step in the right direction has been made. The energetic movement of the center of gravity, and the consequent more safe management of the apparatus, has led him to practise in winds blowing at times over ten meters per second.

"These experiments," he says, "have given the most interesting results that I have arrived at since I began." With a wind velocity of six to seven meters per second, the sailing surface of eighteen square meters carried him against the wind in nearly a horizontal direction from the top of the hill, without even having to run at the start, as is generally necessary. More interesting still is it to learn that, with stronger winds, he allows himself to be simply lifted by the wind from the hill-top and sail slowly against it. The side motion is so strong at times that the operator has to alter the position of his center of gravity considerably to retain his equilibrium.

As experiments have shown, the sailing path is directed strongly upwards by increasing wind force, and this fact causes the operator sometimes to be higher in the air than he was at his original starting-point. In this position his apparatus has occasionally come to a stand-still; whence the following interesting statement:

"At these times I feel very certain that, if I leaned a little to one side, and so described a circle, and further partook of the motion of the lifting air around me, I should sustain my position. The wind itself tends to direct this motion; but then it must be remembered that my chief object in the air is to overcome this tendency of turning to the left or right, because I know that behind and under me lies the hill from which I have started, and with which I would come in rough contact if I allowed myself to attempt this circle sailing. I have, however, made up my mind, by means of either a stronger wind or by flapping the wings, to get higher up and further away from the hill, so that, sailing round in circles, I can follow the strong uplifting currents, and have sufficient air space under and about me to complete with a safety circle, and lastly to come up against the wind again to land."

It may be remembered that Lilienthal has previously employed some mechanical aid, such as the flapping of the wings; an illustration of the apparatus so arranged was given in an article in *Nature*, vol. li., p. 178. Perhaps he will apply the same arrangement to the lower framework of his present apparatus, and thus accomplish the end he is wishing to attain.

One can quite understand that sailing against the wind is one thing, and with it another. In the latter case, since the framework is inclined slightly upwards in the direction of motion, the wind would meet the sailing surface from above, and shoot the operator, arrow-like, to the ground if he were unable to come up to the wind again quick enough. That such circle sailing will be successfully accomplished seems certain, but the first attempts may prove rather rough. Herr Lilienthal has thus shown that, by means of his new apparatus, a very close approximation to flying has been attained.

Should he, however, find that the accomplishment of circling is attended by any great difficulty,—and there appears no reason why it should,—then an important step will have been made, and the future of development of this *Fliegesport* will depend almost directly on the *Fliegepraxis*.

It is interesting to notice that in America this Lilienthal method is about to be tested. In the British Isles Herr Lilienthal has already a follower in Mr. Percy S. Pilcher, of Glasgow University.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

The Machine Shop.

4166. Hints on Machine Design. Charles L. Griffin (An excellent practical article. Young draughtsmen will do well to read these hints). Am Mach–Feb. 13. 700 w.

4351. Reamers without Clearance. T. R. Almond (Practical hints upon the production of reamers very accurately sized, the keeping of these tools in order and upon their use). Am Mach–Feb. 20. 700 w.

4465. Oil as a Fuel for Core Ovens. H. Hansen (Paper read before the meeting of the Western Foundrymen's Assn. Discusses a method of baking cores wherein a number of oil fuel fires in the oven are maintained, thus securing a uniformity of product alleged to be unattainable otherwise). Foundry–Feb. 2800 w.

4466. Molding Sand and its Preparation for Mold and Cores by Old and New Methods. A. E. Outerbridge (A practical discussion of the selection of molding sand and methods of mixing, with a description of Sellers' sand mixer and sifter). Foundry–Feb. 2300 w.

4509. Hints for the Draughting Room. W. S. Huyette (Practical suggestions of value, particularly with reference to keeping records of constructive changes). Mach–March. 1200 w.

4510. Itemized Cost of Castings. Robert Grimshaw (A system of cost accounting for foundry work as carried out in the shops of a well known leading manufacturing establishment). Mach–March. 1400 w.

4513. About Belts—Theory and Rules for Belting. Thomas Hawley (Extract of lecture in Lowell Free Course, at Wells Memorial Inst., Boston. Contains a very thorough résumé of theoretical and practical information upon the subject). Bos Jour of Com–Feb. 29. 3500 w.

4617. Cross-Section Paper in the Shop. William O. Webber (Possibilities of its usefulness unrealized by the mechanical engineer and draftsman in ordinary metal-working establishments). Am Mach–March 5. 800 w.

4618. Molding Cone Pulleys. George O. Vair (Two different plans are illustrated and described). Am Mach–March 5. 650 w.

Steam Engineering.

*4084. Artistic Engine-Room Interiors. Ill. E. T. Adams (Pointing out the tendency to heed the esthetic sense in the designing of engine-rooms, and describing several plants notable in this respect). Eng Mag–March. 2300 w.

*4101. The Schmidt Superheated Steam Motor and Boiler (Illustrated detailed description). Eng, Lond–Jan. 31. 1200 w.

4165. Behavior of a Fly-Wheel Governor under Sudden Changes of Load. Walter Ferris (Illustrated detailed description of apparatus and method employed in an experimental investigation of this important matter. The article is unusually interesting and instructive). Am Mach–Feb. 13. 1800 w.

4209. The Safe and Economical Management of a Steam Plant. Charles H. Garlick (The question is discussed from the practical side purely). Safety V–Feb. 3500 w.

4210. Testing Steam Boilers. C. A. Collett (A practical discussion of methods of ascertaining the safe or unsafe condition of steam boilers). Safety V–Feb. 1700 w.

*4228. Notes on Steam Superheating. William H. Patchell (A paper read before the Inst. of Mech. Engs. Historical, theoretical, and practical, with tabulated data of tests of boilers with and without superheaters). Col Guard–Feb. 7. 4000 w.

*4305. Graphic Methods of Engine Design. A. H. Barker (Will discuss the application of graphic methods to the design of engines in which these methods are often more rapid and satisfactory than mathematical calculations). Prac Eng–Feb. 7. Serial. 1st part. 3500 w.

*4428. Mechanics of the Shaft Governor. John H. Barr (A consideration of the principal points necessary to be observed in the successful design of any of this class of governors). Sib Jour of Engng–Feb. 6000 w.

*4429. Steam. De Volson Wood (Abstract of a lecture delivered before the students of Sibley College. The consideration of the subject is from the scientific and thermodynamic standpoints). Sib Jour of Engng–Feb. 2500 w.

*4562. Notes on Steam Superheating. William H. Patchell (Paper read before the Inst. of Mech. Engs. Historical. Describes a great variety of devices for superheating, from Trevithick's time up to date, and gives in tabulated form the data obtained from the most modern practice in superheating. An excellent paper). Eng, Lond–Feb. 21. 6000 w.

*4563. British Types of Land Boilers (History of land boilers from the time of Desagulier (1718) to date. An interesting and instructive paper read before the Cleveland Inst. of Engs. at Middleborough, Eng , with discussion). Eng, Lond–Feb. 21. 4400 w.

*4584. The Renaissance of Superheating (Editorial. Discussing the increasing practice of superheating steam, states the advantages gained by the practice, expresses the opinion that it is now on a more permanent basis than at any other time since Trevithick invented and used it). Elect'n–Feb. 21. 2200 w.

4603. The Massachusetts Inspection and License Law (A critique. It is maintained that under this act, a man who in a plant of less than 150 h. p. would be unable to get up steam and start the engine, might yet, under this law, be granted a first class license). Lord's Mag–March. 2200 w.

4660. A New Self-Cooling Condenser (This condenser is designed as a substitute for the hitherto costly and bulky condensers used in locations where water supply is very expensive. It is thought to be as efficient as former appli-

ances, while at the same time its bulk and cost are less). Eng News-March 5. 900 w.

*4685. A Curious Old Steam Engine (Engraving of a free hand sketch, accompanied by a description of a Watt Engine at Soho foundry, designed by James Watt during his father's lifetime, and which is estimated to be at least 75 years old). Eng, Lond-Feb. 28. 1000 w.

*4701. Types of Land Boilers. Edward G. Hiller (Paper read before the Cleveland Inst. of Engs. The first part is chiefly historical beginning with the development of steam-boilers in the time of Savery). Prac Eng-Feb. 28. Serial. 1st part. 4500 w.

4714. The Continuous Use of Condensing Water (Illustrated detailed description of a new apparatus for this purpose, installed in the 2d District Station of the Edison Electric Illuminating Co., Brooklyn, N. Y.). Power-March. 2200 w.

4715. The Carbonizing of Wooden Lagging on Cylinders and Pipes (Review of an investigation carried on by the Boston Manufacturers' Mutual Fire Insurance Co. The results are important. It is found that fire hazards are increased by the use of this kind of lagging). Power-March. 1600 w.

4716. Experiments Showing Circulation in Water Tube Boilers (Review and illustrated description of experiments carried out at the works of Yarrow & Co., London, and the results). Power-March. 2500 w.

Miscellany.

4169. High Admission Requirements in Engineering Schools (Editorial. A tendency toward a too high standard of scholastic requirements as a condition of admission into engineering schools is regarded as unfortunate, and as likely to lead to ill effects). Am Mach-Feb. 13. 800 w.

4170. Reliable Approximations versus Guesswork (Editorial. Directed to showing that the approximations of a well matured judgment may often be valuable, as compared with more elaborate calculations, to which they may be valuable checks). Am Mach-Feb. 13. 900 w.

4171. The Uses and Advantages of a Public Supply of Compressed Air. Frank Richards (The many applications to which compressed air, kept in store in cities, to be drawn upon by consumers, could be made useful, is the subject to be considered. The first number appears to be chiefly introductory to the main purpose). Am Mach-Feb. 13. 1000 w.

4175. Japanese Clocks and Pocket Sun Dials (Illustrated description, translated from *La Nature*). Sci Am-Feb. 15. 1800 w.

4177. Some American Motor Carriages (Illustrated description). Sci Am-Feb. 15. 1800 w.

*4198. Recent Developments in Gas Engines. Ill. (Abstract of paper by Mr. Dugald Clerk, read before the Inst. of Civ. Engs., England. The writer reviews the great advances that have been made in gas engine construction, and concludes that it will yet be applied to railways and ships, just as it is now used in factories). Elec Rev, Lond-Feb. 7. 1300 w.

4304. Coal Pockets for a Manufactory (Illustrated detailed description). Eng Rec-Feb. 15. 700 w.

4350. Strength of Shafts. Charles L. Griffin (A diagram for easily determining the diameter of shafts subject to simple bending or twisting, or to both combined). Am Mach-Feb. 20. 200 w.

4436. Wave Motor Experiments (Illustrated description of Gerlach Wave Motor, and of a partially successful experiment with it, soon to be repeated under more favorable conditions). Jour of Elec-Jan. 1. 1800 w.

4440. The Manufacture of Metallic Tubes by the Boulet Process (Detailed illustrated description of processes of making butt-welded tubes, lap-welded tubes, Mannesmann tubes, and tubes by a new process called the Boulet process). Sci Am Sup-Feb. 29. 2900 w.

4477. Recent Developments in America of Mechanically-Propelled Road Carriages (First part is a general review of progress in the art, with illustrated descriptions of various carriages of the class, and will be followed by more or less detailed descriptions of other examples of this kind of vehicles). Eng News-Feb. 27. Serial. 1st part. 3500 w.

*4506. English Steam Carriages. Ill. William Fletcher (The leading feature of this article is the discussion of weight as related to the different purposes for which this class of vehicles is adapted). Mach, Lond-Feb. 15. 1500 w.

4507. Strength and Wear of Gear Wheel Teeth. Bell Crank (A critical review of the subject with reference to recent articles on the same subject which have appeared in this paper). Mach-March. 1300 w.

4508. Helical Gearing Cisnarf (Practical information supplementing the theoretical information given in text-books). Mach-March. 1500 w.

4604. Gas Motor Crane. C. Jimels (Translated from *Le Génie Civil*. Illustrated detailed description of an installment erected by the Parisian Gas Light and Heating Co. Handles 1200 kilos of coal at each load, lifting it 21 meters, together with the bucket which weighs 500 kilos, at the rate of 30 meters per minute). Pro Age-March 1. 1800 w.

4621. Entrance Requirements, Endowment and Scholarships at Cornell University (Letter to the editor from R. H. Thurston, with editorial remarks). Am Mach-March 5. 3800 w.

4657. The Possibilities of Mechanically-Propelled Vehicles for Common Roads (Editorial. The subject is discussed in relation to the questions: (1) to what sphere of usefulness are such vehicles best adapted? (2) in what direction had we best work in design and construction to fulfill the conditions of desirable, efficient and safe modes of conveyance? It is thought the motor carriage will be of greatest use when applied to mercantile purposes, for delivery, etc., of goods in cities, for which purpose long distance capacity and high speed are not needed). Eng News-March 5. 3200 w.

MINING & METALLURGY

The Education of Metallurgists.

TECHNICAL education in the United States has received so much unsolicited encouragement, both from the demand for technical graduates, and from State appropriations, that those not directly interested do not appreciate our relative educational position among nations, and take the whole situation as a matter of course—as an example of our enterprise. It is only when we compare the elaborate and excellent equipment of our laboratories and the strictly technical character of the instruction with those of our principal competitors in the metallurgical industries, that we begin to realize our own status and to find a reason for the rapid development of our iron, steel, copper, and metal-refining industries. Mr. Thomas Turner, in a paper before the South Staffordshire Institute of Iron and Steel Works Managers, which was published in the *Iron and Steel Trades Journal* (Feb. 15), says:

"The most notable fact in the history of the iron trade for the last fifteen years has been that, while at the beginning of that period England had an undoubted supremacy in the iron trade of the world, America has become the premier iron-producing country, while Germany runs the United Kingdom very closely for the third place; and, further, that, while these two countries have thus enormously increased their output, the produce of our own country has diminished instead of increasing. It is, perhaps, scarcely necessary to point out that in Germany and America more attention has been devoted to technical construction in metallurgy and other cognate subjects than in any other country in the world. The work of Germans in this respect is too well known to need further reference, while the advances in the provision of higher education in America have been, during recent years, most remarkable. Mr. Mundella has recently reminded us that in 1883 there were in Germany 24,000 university students against 5,500 in this country. The fees in Germany were about 30s. per annum as against about £30 in the United Kingdom. No doubt, in the interval that has since elapsed, we have made much progress, but there is still need for extended higher training at a moderate cost, and for this purpose increased State aid to university colleges is necessary. Apparently what is wanted is scientific and manual training for the men, together with the very highest technical instruction in metallurgical science for the masters and others who have to lead."

The author here examines into the work of the various institutions in England which include metallurgy in their curriculum. He concludes that the lack of instruction for workingmen is principally due to the apathy of the men themselves, and that, as soon as the want is made known, the means for such instruction will be supplied. For higher instruction he considers that the laboratories now being used are not adequate, and that the instruction abounds in superfluous subjects which make the graduate more of a scientific than a technical man, and therefore usually a disappointment to the iron works managers.

"Until metallurgical teaching is placed on the same basis as, say, that of chemistry or physics, with an independent professor, having a seat upon the board of studies with properly-equipped laboratories, and with efficient apparatus, comparatively little progress can be anticipated in the university colleges. I venture to submit that in the United Kingdom we at present are, or at all events soon shall be, in as good a position to educate our workingmen in metallurgical subjects as are our competitors, but that the provision for the education of our masters is at present inadequate. The interesting question to be solved during the next few years is as to whether that which is required

shall be supplied by the university colleges, to whose province it more strictly belongs, or by the technical schools which are now springing up all over the country. To the iron manufacturer the place at which his son is educated is a matter of indifference, so long as the proper education can be obtained. But the educationalist would prefer that the systematic course of instruction, commencing not earlier than in the student's sixteenth year, extending over three years, and requiring the whole of the student's time during that period, should, as far as possible, be conducted in connection with a university college, and should be certified to with the stamp of a university degree."

In the discussion following the paper the ideas coming from professors of metallurgy and lecturers coincided in the main with those of Mr. Turner. Prof. Arnold said that higher technical education would probably be opposed by vested interests, but would be supported by every technical instructor in the country. It appears that the lack of enterprise in the English ironmaster is the cause of his own threatened downfall.

The So-Called Selective Action of Cyanid.

THE problem of handling low-grade gold ores economically has been left to wet methods for solution almost entirely; metallurgical and mechanical processes are far too inefficient where large bodies of valueless gangue have to be handled, due largely to the cost of supplies incident upon the usual isolated location of the mines. Of all these wet processes, the only one which has attained any practical importance is the MacArthur-Forrest cyanid process, which is controlled by a company of speculators who have secured patents in most of the civilized countries, compelling the payment of royalties by all using the process. Owing to the extended application of cyaniding, these royalties became burdensome, and efforts are being made to prove the patents not valid. As an example of one of the arguments advanced against the company's claims, we abstract from an article in *The Australian Mining Standard* (Jan. 16), by Mr. James Mactear, which was read as a paper before the Institution of Mining and Metallurgy.

"It has been stated in one of the MacArthur-Forrest patents that 'in practice we find the best results are obtained with a very dilute solution, or a solution containing or yielding an extremely small quantity of cyanogen or a cyanid, such dilute solution having a selective action such as to dissolve the gold or silver in preference to the baser metals.' This, no doubt, seems to be a very definite assertion, but, when one begins to examine the actual facts, it is seen to be incorrect. As a matter of fact, no statement has ever yet been made—and supported by experiments—to prove that a strong solution 'attacks the baser metals without attacking the gold,' nor that the action of 'a weak solution is feeble and nil on the baser metals, but attacks the gold.'

"In discussing the question, it is necessary to bear in mind the fact that two types of action are involved. Firstly, the action of chemical affinity; and, secondly, the action of such chemical affinity assisted or modified by an electric current."

First, the author shows, from the experiments of Dr. Gore, the action of cyanid of potassium on "the above absolute proportionate weight of the various *metals* dissolved or 'corroded' from one square inch of surface in one hour. Taking the amount of gold dissolved as 100 parts, the following are the proportions for the metals named:—

Aluminum.....	1055	Gold.....	100
Zinc.....	600	Tin.....	66
Copper.....	588	Nickel.....	55
Silver.....	177	Iron.....	Trace

"It will be seen at a glance that gold is in the middle of the table, and that aluminum, zinc, copper, and silver are more readily soluble, or, in other words, the 'selective action,' so far as these metals are concerned, is in their favor, and against gold; while tin, nickel, iron, and platinum are less soluble, and as regards these metals the 'selective action' will be in favor of gold."

The *metallic oxids* were next experimented with, using three strengths of cyanid of potassium solution in the pres-

ence of metallic gold for a period of twenty-four hours. The results were as follows:

	I.	II.	III.
Cyanid of potassium in 1,000 parts of solution	5	20	50
Proportion of gold dissolved (No. 1 taken as 100)	100	237	550
Proportion of base metal oxids dissolved	100	100	100

"It will be observed that the proportion of base metal oxid remained constant for each of the three strengths of solution, the explanation of this fact being that the whole of the oxids were dissolved in each case, while the proportion of gold dissolved by the solutions increased with the strength of the solution, the whole of the gold, however, not being dissolved even in the case of the strongest solution.

"The *base metal compounds* most commonly met with in gold ores are the sulphids of iron, copper, lead, and zinc, in the form of iron and copper pyrites, galena, and zinc blende. In the case of these sulphids very considerable differences are met with in regard to the rate at which they are dissolved, their physical condition as well as their chemical composition affecting the action of the solution of cyanid of potassium upon them. Whatever the strength of the solution, its action is complicated by the presence of alkali as caustic or carbonate of potash, either present originally in the solution, or produced in it by the reactions taking place in the process. This alkali acts on the sulphid in certain cases, complicating the reactions, but experiment shows that, as a general rule, the amount of base metal dissolved is much greater than the gold or silver dissolved, even where oxygen is present. Thus, in the case of clean unoxidized iron pyrites containing gold equal to 11 dwt. 10 grains per ton, the finely-powdered ore was treated with half its weight of a solution containing 1.22 per cent. cyanid of potassium (equal to 0.49 per cent. cyanogen) for a period of 24 hours. The relative amounts of gold and base metal sulphids dissolved were—

	oz.	dwt.	gr.
Gold	0	8	14
Iron, as FeS_2	41	13	0

the percentage extraction of the gold being equal to 75.6 per cent., while 78.7 per cent. of the cyanogen had been used up."

Second: "So far we have been dealing with the question of solvent or chemical action only, but it is impossible to discuss the matter from this point of view alone, and it is necessary to consider the question of the 'selective action,' of dilute solutions upon ores as involving the effect of electric action also. If we now consider how this galvanic couple action affects the question of the so-called 'selective action,' there can be but little doubt that the solution of the gold is considerably accelerated by such an action. In the first instance, it may be well to place beyond doubt the fact that an electric current does very materially facilitate the solution of gold by cyanid of potassium."

Gold leaf was immersed in a dilute cyanid solution out of contact with either cathode or anode, and it was found that the same quantity was dissolved in 1½ minutes with the electric current acting as was dissolved in 10 minutes without the current. Experiments on ore gave varying results.

"There is, however, no doubt that, if the action of the cyanid solution be arrested immediately the gold has been dissolved, the dilute solution will be found to have dissolved—in the case of most ores containing sulphids—less of the baser metal compounds than will have been dissolved by the stronger solution. But this naturally follows, there being even in the most dilute solution employed an enormous excess of cyanid of potassium over the amount required for the solution of the gold, the excess cyanid, of course, exerting its solvent action upon the base-metal compounds. For example, the most dilute solution indicated in the MacArthur-Forrest patent is to contain 2 parts of cyanogen to 1,000 of water. If such a solution be used to treat an ore, such as Transvaal tailings containing 15 dwt. of gold per ton, there will be present about 160 times more cyanogen than is chemically required for the gold dissolved.

"Surely it is a mistake to call this a 'selective action' in favor of the gold. The answer to the statement, as given in the

judgment of the court of appeal, with which we started, that 'a strong solution attacks the baser metals without attacking the gold, whereas a weak solution is feeble and nil on the baser metals, but attacks the gold,' is entirely contradicted by the results of both experimental and practical working of the process, which show in almost every case that the action of solutions of cyanid of potassium, whether strong or weak, is to dissolve a much larger actual weight of base metal compounds than of gold, while the electrochemical action set up by the formation of galvanic couples plays a most important part in the reactions that take place, the effect of which has not hitherto been sufficiently recognized."

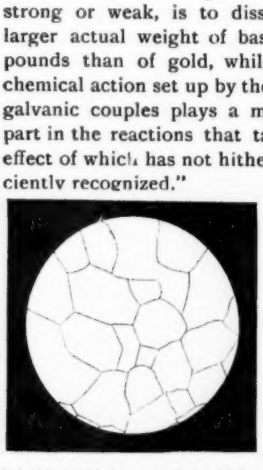


FIG. 1.—Primary crystals of pure copper. Slowly cooled. Magnified 11 diameters. Viewed with oblique light.

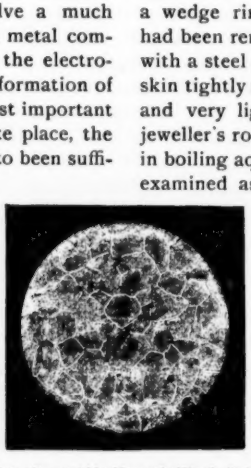


FIG. 2.—Copper containing 0.5 per cent. of bismuth. Slowly cooled. Magnified 11 diameters. Viewed with direct light.

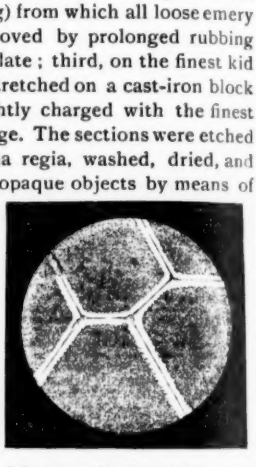


FIG. 3.—Copper containing 0.5 per cent. of bismuth. Slowly cooled. Magnified 66 diameters. Viewed with direct light.

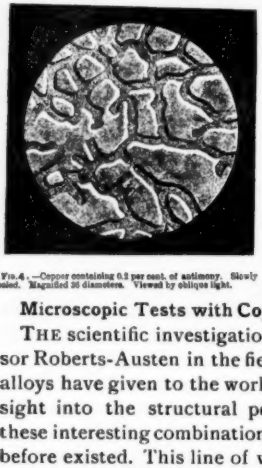


FIG. 4.—Copper containing 0.2 per cent. of antimony. Slowly cooled. Magnified 36 diameters. Viewed by oblique light.

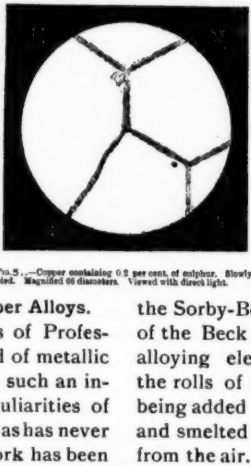


FIG. 5.—Copper containing 0.2 per cent. of sulphur. Slowly cooled. Magnified 66 diameters. Viewed with direct light.

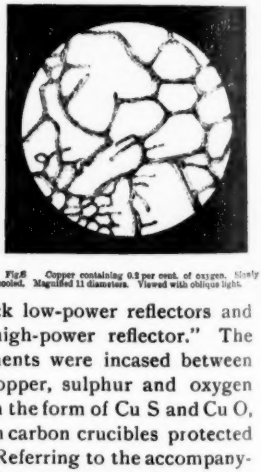


FIG. 6.—Copper containing 0.3 per cent. of oxygen. Slowly cooled. Magnified 11 diameters. Viewed with oblique light.

Microscopic Tests with Copper Alloys.

THE scientific investigations of Professor Roberts-Austen in the field of metallic alloys have given to the world such an insight into the structural peculiarities of these interesting combinations as has never before existed. This line of work has been followed in the direction of microscopical examination of structure by Messrs. Arnold and Jefferson of the Sheffield Technical School, who report in *Engineering* (London, Feb. 7) the results of the tests of gold and copper alloys. The alloys prepared for the microscope by having "sections turned from the somewhat quickly cooled cast bars were 7.5 millimeters in diameter and 2.5 millimeters thick. They were polished, first, on fine emery cloth; second, on fine emery cloth (tightly stretched on a cast-iron block by means of a wedge ring) from which all loose emery had been removed by prolonged rubbing with a steel plate; third, on the finest kid skin tightly stretched on a cast-iron block and very lightly charged with the finest jeweller's rouge. The sections were etched in boiling aqua regia, washed, dried, and examined as opaque objects by means of the Sorby-Beck low-power reflectors and of the Beck high-power reflector." The alloying elements were incased between the rolls of copper, sulphur and oxygen being added in the form of Cu S and Cu O, and smelted in carbon crucibles protected from the air. Referring to the accompanying sections, the authors remark:

"*Pure Copper* (Fig. 1).—This drawing reproduces the primary crystals of pure

copper magnified as before. Under high powers minute globules of the sulphid of copper were readily detected, although only 0.002 per cent. of sulphur was present. A shadowy granulation around the edges of the crystals also indicated the presence of traces of oxygen. In the copper alloys, unlike those of gold and excepting in the case of sulphur, the cell walls appeared in relief, being less soluble in the boiling dilute aqua regia used for etching than the copper itself.

"*Copper and Bismuth* (Fig. 2).—To obtain more conclusive evidence, an alloy containing 0.5 per cent. bismuth was made. The bismuth occurs not only as cell walls, but in isolated irregular globules. Prof. Goodman has shown that the addition of small percentages of metals of high atomic volume produces a remarkable increase in the friction of bearings. This fact appears to be explained by the behavior of the present alloys. It was observed during polishing that the isolated globules of bismuth, and indeed portions of the membranes themselves, fell out, the result being that the polishing track on the kid skin became coated with gray bismuth powder, and an increase in the friction was manually distinct. After etching, the section was slightly repolished, when the cavities formed by the falling out of the globules and membranes became filled with a mixture of rouge and bismuth powder, then presenting the appearance figured.

"*Copper and Bismuth* (Fig. 3).—It will be noticed that the sectional bismuth meshes each present a remarkably definite and straight plane of cleavage. Figs. 2 and 3 seem to offer a satisfactory explanation of the enormous falling off in the electrical conductivities of copper produced by the addition of small quantities of bismuth. A current, in the case of the pure metal, traverses a series of cohesive copper crystals; in the bismuth alloy it has, in its passage from one crystal of copper to the next, to pass through a wall of bismuth divided by a cleavage plane. A micrographic analysis of the metal bismuth itself reveals the presence of innumerable planes of cleavage resembling those of calcite,—a fact which probably accounts for its high electrical resistance.

"*Copper and Antimony* (Fig. 4).—This section shows that the latter metal produces very thick brown cell walls or sectional meshes, which seem in volume or area altogether out of proportion to the percentage of antimony present. However, on examination at high powers, the antimonid meshes are found to possess a distinct compound structure, consisting of alternate light and dark laminae, suggesting that in the first instance an attenuated antimonid involves the copper cells at a high temperature, but at a lower temperature the walls split up into plates of pure copper, alternating with those of a less basic antimonid. In this alloy the secondary crystals of copper contained within the antimonid membranes consist of remarkably perfect octahedra. This illustrates a fact noted throughout the present investigation—that thick cell walls usually inclose very geometrical secondary crystals, suggesting that the perfection of the latter is due to the protective action of the walls in relieving the cells themselves from contraction stresses.

"*Arsenic and Copper*.—The alloy containing about 0.2 per cent. arsenic presented a structure resembling that of the antimony alloy. The meshes, however, were green in color, and their compound structure was granular rather than laminated. Also the lines of division between the cells and walls were less acutely defined than those of the antimony alloy.

"*Copper and Sulphur* (Fig. 5).—The section of this alloy presented well-defined and geometrical primary crystals surrounded by somewhat attenuated sulphid walls. The sulphid also occurred in the form of green globules in the interior of the crystals, or sometimes near the edges in groups of elongated leaves. Sulphid which has escaped corrosion by the etching acid is green, but the cavities from which it has been dissolved out present a red-brown color. Often isolated globules or elongated patches of the green sulphid appear in the brown cavities between the copper crystals.

"*Copper and Oxygen* (Fig. 6).—This sec-

tion is that of copper containing 0.2 per cent. of oxygen reduced from a drawing magnified 40 diameters. The cuprous oxid arranges itself in granular shadowy meshes, not only between the primary crystals, but also in the interior of the latter.

"*Zinc and Copper.*—Zinc appears to dissolve in copper, certainly in proportions up to 0.5 per cent., without producing any noticeable change in the micro-structure. Its behavior with copper appears to be identical with that of silver with gold.

"*Copper and Silicon.*—The structure of this metal presented a marked resemblance to that of the gold-silicon alloy, the sectional meshes of silicid being, however, in relief, granular in structure, and larger and less elongated than those of the gold alloy.

"It will be obvious that the facts recorded in the present paper open up a wide field of research, not only in metallurgy, but also in chemical physics."

High Explosives in Mines.

"AT a meeting of the North of England Institute of Mining and Mechanical Engineers held on Feb. 15," says *The Practical Engineer* (Feb. 21), "Mr. A. C. Kayll presented the report of the proceedings of the Flameless Explosives Committee." The explosions were made with bellite, securite, ammonite, roburite, carbonite, ardeer powder, and westfalit, in mixtures of coal-dust air and pit gas. The lengthy series of experiments, which has occupied the attention of the committee since March, 1892, appears to establish the following conclusions:

"1. The high explosives (ammonite, ardeer powder, bellite, carbonite, roburite, securite, and westfalit), on detonation, produce evident flame.

"2. The high explosives are liable to ignite either inflammable mixtures of air and fire damp, or air and coal dust, or air, fire damp, and coal dust, and therefore cannot be relied upon as ensuring absolute safety when used in places where such mixtures are present.

"3. The explosives are less liable than blasting powder to ignite inflammable mixtures of air and fire damp, air and coal dust, and air, fire damp, and coal dust.

"4. The experiments have shown that ignitions of mixtures of air and coal dust, with or without the presence of fire damp, can be obtained when there is present a much smaller quantity of coal dust than has been previously supposed to be necessary.

"5. It is essential that similar examinations of the working places and precautions which are in force in mines where blasting powder is used should be rigidly observed when a high explosive is employed.

"6. In selecting a high explosive for use in a mine, it should not be forgotten that the risk of explosion is only lessened, and not abolished, by its use.

"7. In view of the changes from time to time made in the proportions and constituents of high explosives, it is desirable that the name of the explosive should be printed on the wrapper of each cartridge, and that the date of manufacture and the proportion of the ingredients used in the manufacture of the explosive should be printed on the case of each packet of cartridges.

"8. As these explosives alter in character if improperly kept, it is necessary that every care should be taken in the storage to ensure their being maintained in good condition."

Sampling Ore.

THOUGH mechanical samplers have given satisfaction in large works, the usual methods of hand sampling possess so much flexibility as to be of universal application, and consequently are used everywhere with local modifications. The method employed in California is thus described by the *Mining and Scientific Press* (Feb. 22):

"When a quantity of ore is to be sampled, it is first broken by an ordinary rock-crusher into pieces the size of an English walnut, after which it is shoveled back into the car, but in such a manner that every fifth shovelful is thrown aside by itself, the remaining four-fifths being finally taken away. The fifth portion,

known as the 'sample,' is then reduced to a much greater degree of fineness by means of Cornish rolls. It is then piled on the floor in a cone, flattened out and divided into four equal portions, and two opposite quarters are then removed. The remaining quarters are again thoroughly mixed and again piled in a cone, flattened and quartered, this operation being repeated until the sample is reduced to one hundred pounds. It is then weighed repeatedly for the purpose of determining the amount of moisture contained in the ore, which in some ores, especially those of the concentrates, is so considerable as to make a very appreciable difference in the weight. The moisture is then expelled, and the ore is crushed to such a degree of fineness that it can be passed through a sieve containing one hundred holes in the linear inch. The sample is next put up in small bottles, which are sealed with sealing wax and then stamped, for the purpose of preventing the possibility of their being opened or tampered with without detection."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Mining and Engineering Journals—See Introductory.

Metallurgy.

*4087. Practical Assaying at Mines and Works. H. Van F. Furman (Showing the methods of securing rapidity and accuracy in metallurgical works). Eng Mag–March. 3000 w.

*4100. Coal Dust Fuel (From the *Zeitschrift des Vereins Deutscher Ingenieure*, containing a tabulated statement of the heat distribution with the Wegener and the Schwartzkopff burners, with several kinds of powdered coal). Eng, Lond–Jan. 31. 1400 w.

*4116. The Effect of Silicon on Iron. M. Moissan (A paper communicated to the Académie des Sciences, Paris, giving the results of his experiments in making siliciurets in an electric furnace). Ir & St Trs Jour–Feb. 1. 600 w.

*4118. Copper. Nelson Dawson (Read at meeting of Arch. Assn. followed by discussion. History of the metal and its uses). Builder–Feb. 1. 9000 w.

*4123. Electrometallurgy in 1895. E. Andreoli (The encouraging progress in the applications of electrolysis to metallurgy). Elec Rev, Lond–Jan. 31. 3400 w.

*4124. The Aluminum Industry. G. L. Addenbrooke (The last year has proved a quiet but eventful one in this industry, and the work accomplished is reviewed). Elec Rev, Lond–Jan. 31. 2200 w.

*4145. Strength of Bronze in Compression. S. Bent Russell (These original tests are quite valuable. The results are shown in diagrams and tables, and fully discussed). Jour of Assn of Eng Soc–Dec. 1200 w.

4150. The Canadian Pig Iron Industry. George E. Drummond (An article of commercial interest, showing that Canada is using and producing more iron than is generally supposed. The producing localities are treated in detail). Can Eng–Feb. Serial. 1st part. 3300 w.

†4182. Iron Industry of Russia (Translated from the Vienna Hendels-Museum. The report shows that there is a large demand in Russia for pig iron and iron manufactures, and the industries are advancing so rapidly that foreign manufacturers will find a ready market for their products, though at small profits). Cons Reports–Feb. 2300 w.

4214. Milling in the Cooney Mining District, New Mexico. Carl Anderson (A tabulated statement itemized by months, and nine heads of expenses, etc., of results obtained by improved methods in silver milling. The author corrects a previous description by Mr. L. W. Tatum). Eng & Min Jour–Feb. 15. 500 w.

*4226. The Iron Industry of Austria-Hungary (From a British Foreign Office Report, describing the mines, charcoal furnaces, and iron works in Styria and Betler). Col Guard–Feb. 7. 1200 w.

*4230. Some Notes on Eastern Metallurgy (The methods of producing weapons of keen edge and ornamental appearance is referred to and briefly described). Ir & Coal Trs Rev–Feb. 7. 1800 w.

*4231. New Proposals for the Utilization of Blast-Furnace and Producer Gases (Description of a system now being tested for the utilization of a blast furnace as a gas producer, the production of iron being a secondary operation). Ir & Coal Trs Rev–Feb. 7. 1600 w.

*4235. Parkhead Forge, Rolling Mills and Steel Works. Ill. (Description of a notable English iron-works). Eng, Lond–Feb. 7. Serial. 1st part. 3500 w.

*4245. The Consett Steelworks (General description of a notable English works, illustrated by views). Ir & Coal Trs Rev–Jan. 31. 3300 w.

*4246. The Seraing Works of the Cockerill Company, Belgium (This company employ 10,000 men in its mines and works. The wages of the men are given, and the works described). Ir & Coal Trs Rev–Jan. 31. 2000 w.

*4247. The Micrographic Analysis of Metals. J. O. Arnold (The writer shows how the microscope may be utilized in the study of the fundamental structure of iron and steel). Ir & Coal Trs Rev–Jan. 31. 2200 w.

*4248. Recent Progress in Open-Hearth Steel Making. Bernard Dawson (The increasing demand for steel castings, improvements in charging and furnace construction, and the pro-

duction and application of mild steel are treated in an interesting manner). Ir & Coal Tr Rev-Jan. 31. 2800 w.

*4249. Notes on the Electro-Crucible Fusion of Steel and Iron. B. H. Thwaite (The writer shows that in the electric furnace 16.05 % of the value of gas-engine fuel is utilized, while in ordinary furnaces but 3 09 % goes toward melting in the furnace). Ir & Coal Trs Rev-Jan. 31. 2500 w.

*4251. Economy of Electrical Power in the Iron and Steel Industries (A general article showing the growing application of electricity to machinery). Ir & Coal Trs Rev-Jan. 31. Serial. 1st part. 2000 w.

*4252. Foundry Practice at Home and Abroad (Recent developments and improvements). Ir & Coal Trs Rev-Jan. 31. Serial. 1st part. 1500 w.

*4253. Recovery of By-products and Utilization of Waste Gases in Coke Ovens (Practice in England and on the continent). Ir & Coal Trs Rev-Jan. 31. 2000 w.

*4254. Regulating the After-Blow in the Basis Process (The article recommends the reduction of time in the after-blow in the basic Bessemer converter, thus reducing the quantity of iron in the slag and increasing dephosphorization). Ir & Coal Trs Rev-Jan. 31. 800 w.

*4257. Some Recent Features of the American Iron Industry (With special reference to the enterprise of Americans and the magnitude of their undertakings). Ir & Coal Trs Rev-Jan. 31. Serial. 1st part. 1700 w.

4258. Loss in the Thomas Process. Abstract from *Stahl und Eisen* (The article gives the total loss ranges between 13 % and 17 %, itemized). Am Mfr & Ir Wld-Feb. 14. 700 w.

†4276. Methods for the Collection of Metallurgic Dust and Fume. Malvern W. Iles (A valuable synopsis with a brief description of each of the eight processes which have been used for the purpose). Sch of Mines Quar-Jan. 10500 w.

†4278. Notes on the Assay of Rich Silver Ores. Edmund H. Miller and Charles H. Fulton (The object of this work is to locate the loss of silver in the different operations, essential to the assay of a rich silver ore, by determining the amounts which can be recovered from the slags and cupels. Also to determine the best method of assaying two particular ores). Sch of Mines Quar-Jan. 2700 w.

†4279. An Explosion in a Zinc-Fume Condenser. Charles F. McKenna (The explosion which wrecked one end of the condenser was attributed to spontaneous combustion of pyrophoric zinc fumes). Sch of Mines Quar-Jan. 1500 w.

*4291. Influence of Small Quantities of Impurities on Gold and Copper. J. O. Arnold and J. Jefferson (The experiments showed that metals with relatively high atomic volumes when alloyed with gold, made the alloy fragile, while those of about the same atomic volume produced little effect. The article is illustrated by twelve microscopic sections of alloys of gold and copper with bismuth, silver, aluminum, silicon, antimony, sulphur and oxygen). Engng-Feb. 7. 3600 w.

†4328. Assays of Copper and Copper Matte (Discussion of the results presented at the Florida meeting, 1895). Trans Am Inst of Min Engs-Feb. 3300 w.

†4329. The Accumulation of Amalgam on Copper Plates. R. T. Bayliss (The author shows that the gold fineness of the amalgam on the plates is highest near the battery, while the corresponding silver fineness is highest further away). Trans Am Inst of Min Engs-Feb. 2200 w.

†4330. The Effect of Vibration upon the Structure of Wrought Iron (Continued discussion). Trans Am Inst of Min Engs-Feb. 1700 w.

†4331. Note on Carbon-Bricks in the Blast Furnace. R. W. Raymond (The bricks have proven quite satisfactory but have not been used long enough to determine the life). Trans Am Inst of Min Engs-Feb 600 w.

†4332. The Effect of Washing with Water upon the Silver Chloride on Roasted Ore (Discussion of the paper of Mr. Willard S. Morse, by L. D. Godshall). Trans Am Inst of Min Engs-Feb. 2800 w.

†4333. Notes on the Handling of Slags and Mattes at Smelting-Works in the Western United States. William Braden (Designs of settling pots and fore-hearths are given and the practice in the principal works described). Trans Am Inst of Min Engs-Feb. 3700 w.

†4334 Gold-Milling in the Black Hills, South Dakota, and at Grass Valley, California. T. A. Rickard (Comments suggested by visits to the stamp mills of both localities with valuable tables of cost, consumption of mercury, labor employed and illustrated descriptions of the later installations). Trans Am Inst of Min Engs-Feb. 9000 w.

4353. Rolling-Mill Feed Table. Ill. (The device consists of endless chains with roller link joints, which are cooled by passing through water under the feed table). Ir Tr Rev-Feb. 13. 600 w.

4354. Dynamite in Blast Furnace Practice. John S. Kennedy (The method, with precautions, is described and the method of applying cartridge is illustrated). Ir Tr Rev-Feb. 13 900 w.

4355. Coke for the Foundry. Thomas D. West (Its characteristics, methods of manufacture and a founder's experience with it. Illustrated by sections of coke ovens). Ir Tr Rev-Feb. 13 Serial. 1st part. 1400 w.

4364. Coking in Upper Silesia. M. Gouvy (A paper communicated to the Soc. of Mineral Industry, St. Etienne, France, giving general description of the several plants, with statistics). Am Mfr & Ir Wld-Feb. 21. 1500 w.

*4365. Aluminum Bronze (Abstract from the *Aluminum World*. The properties are described). Aust Min Stand-Jan. 16. 700 w.

4367. The Aluminum Industry. Orrin E. Dunlap (Electric smelting at Niagara Falls is described, and the yearly production since 1383 is tabulated). Min & Sci Pr-Feb. 15. 1400 w.

*4389. Technical Instruction in Its Application to Ironmaking Thomas Turner (The paper is given in full, with discussion. Read before the South Staffordshire Inst. of Iron and Steel Works' Managers). Ir & St Trs Jour-Feb. 15. 5300 w.

*4421. The Manufacture of Aluminum by Electrolysis, and the Plant at Niagara for its Extraction. Alfred E. Hunt (Read before the Inst. of Civ. Engs. The description is condensed and gives many details of the process). Col Guard-Feb. 14. 1300 w.

*4422. The Chemistry of the Siemens Furnace. A. M. Dick and C. S. Padley (Paper read before the West of Scotland Iron and Steel Inst. A comprehensive, elementary explanation). Col Guard-Feb. 14 1700 w.

4446. Galvanizing. W. T. Flanders (The process is described in detail). Ir Age-Feb. 27. 3000 w.

4447. Bessemer on Nickel Steel (Interesting notes from Sir Henry Bessemer's note book which are made as far back as 1842). Ir Age-Feb. 27. 1700 w.

4448. The Morgan-Allen Continuous Heating Furnaces (Description illustrated by drawings in plan and section. Each charge of these billets pushes the others toward the drawing door). Ir Age-Feb. 27. 600 w.

4460. Modification of the Chlorination Process (The process consists in the addition of caustic soda and slaked lime to the ores, to prevent the deterioration of the salt employed. The rationale is fully treated). Min & Sci Pr-Feb. 22. 1400 w.

4464. A Furnace Plant in Alabama. "Englasia" (Well illustrated description of furnace, coking ovens, hoists and cars). Foundry-Feb. 900 w.

4475. The Mobility of Molecules of Cast Iron. Alex. E. Outerbridge, Jr. (A paper read at the Pittsburg meeting of the Amer. Inst. of Min. Engs. As the result of experiments the surprising statement is made that "cast iron is materially strengthened by subjection to shocks or repeated blows"). Eng News-Feb. 27. 3000 w.

*4516. The Treatment of Antimony Ores (Discussion of the New Halloway-Longridge process for extracting gold from antimony ores. It is interesting because little is known of the metallurgy of antimony). Min Jour-Feb. 22. 1800 w.

4519. Selling of Pig Iron on Analysis. C. R. Baird & Co. (Response to a letter from William R. Webster, asking C. R. Baird & Co. to give the results of their experience in selling pig iron on analysis. Presented at the Pittsburg meeting of the American Inst. of Min. Engs., as part of the discussion on "The Physics of Cast Iron"). Ir Tr Rev-Feb. 27. 900 w.

4520. The Latest in "Baby Bessemer' Practice. H. L. Hollis (Synopsis of a paper entitled "Notes on the Walrand-Legenisel Process for Steel Castings" read at the Pittsburg meeting of the Amer. Inst. of Min. Engs). Ir Tr Rev-Feb. 27. 1200 w.

4521. Expansion and Shrinkage of Cast Iron. William R. Webster (Contributed to the discussion on "The Physics of Cast Iron" at the Pittsburg meeting of the Amer. Inst of Min. Engs. The results of tests made in 1889 are plotted in curves, and the manner of making the tests is illustrated and described). Ir Tr Rev-Feb. 27. 500 w.

*4565. The Iron and Steel Industries of South Russia (The first of a series of short illustrated articles. It describes the Krivoi Rog Iron Works, which have a production of 50,000 tons of pig iron per year). Ir & St Trs Jour-Feb. 22. Serial. 1st part. 1100 w.

4601. The Walrand-Legenisel Process. H. L. Hollis (Read at the Pittsburg meeting of the Am. Inst. of Min. Engs. This consists essentially in adding ferrosilicon at the time the flame drops in a Bessemer converter and making an after-blow, with the idea of preventing blowholes in castings). Ir Age-March 5. 1500 w.

*4612. How Germany Cancelled the Cyanide Patent. G. G. Turri (A translation of the decision of the Imperial German Court by which the cyanide patent was cancelled. The argument is given in full). Aust Min Stand-Jan. 30. 2400 w.

†4616. The History of Electric Heating Applied to Metallurgy. Frederic P. Dewey (Read before the Washington Section. A description of the several forms of apparatus which have been designed and used up to the present time. Illustrated by 13 cuts). Jour Am Chem Soc-March. 7000 w.

4654. The Comparative Efficiency of West Virginia Coals. James W. Paul (The composition of 17 varieties of coal with their thermal efficiency and other characteristics are given). Eng & Min Jour-March 7. 800 w.

*4696. The Practical Determination of the Binding Power of Coal. Louis Campredon (Paper read at the Académie des Sciences de Paris. The author shows by examples that the composition of coals does not indicate their coking properties). Ind & Ir-Feb. 28. 800 w.

*4697. The Direct Puddling of Iron. Emile Bonehill (The author's reply to the discussion of his paper on Direct Puddling, read at the Iron & Steel Inst. meeting. It contains much detailed information). Ir & St Trs Jour-Feb. 29. 2200 w.

†4699. Smokeless Firing and Powdered Coal for Steam Boilers (Description of the Wegener apparatus). Ind & East Eng-Feb. 8. 600 w.

Mining.

*4085. Prospecting with the Diamond Drill. Ill. J. Parke Channing (Showing the methods employed in the different classes of diamond drilling, the difficulties encountered, and the devices resorted to in case of mishap). Eng Mag-March. 4500 w.

*4096. New Belgian Regulations as to the Use of Explosives in Collieries (From a Belgian Royal decree, dated 13th Dec., 1895: The rules are intended to lessen accidents due to explosives). Col Guard-Jan. 31. 1800 w.

*4097. Working Mines by Mortgagees in

Possession (Cases in equity defining the privileges of the party holding mortgage). Col Guard–Jan. 31. 1800 w.

*4098. The Air of Coal Mines. Frank Clowes (A lecture delivered at the University College, Nottingham, showing that the flame test was not reliable in the presence of carbonic oxide, but that mice are twenty times more sensitive to it than a man, and that blackened coagulated blood will turn pinkish in the presence of carbonic oxide; therefore, these tests might be of practical utility). Col Guard–Jan. 31. 700 w.

†4180. American Coal for Belgium (A translation from *The Industrial Review*, of Charleroi, is quoted which shows, by calculations, that the shipping of coal from America to Europe can be accomplished at a profit. The consul agrees, suggesting Ghent as the best port for cotton vessels, with coal ballast). Con Rept–Jan. 1600 w.

4188. The Butterfield Tunnel Scheme (A remarkable tunnel reaching a depth below the surface of 2200 ft. and having a length of 8200 ft. It will tap and drain the two mines owned by the company). Min & Sci Pr–Feb. 8. 1600 w.

4189. The Woods' Dry Placer Miner (The device consists of a disintegrator, resembling an inclosed ore washer, which delivers its pulverized product to an inclined table having riffles at intervals and having a bottom of coarse cloth through which a bellows underneath drives the air in pulsations as in jigging. The gold settles to the surface of the cloth and is there collected). Min & Sci Pr–Feb. 8. 650 w.

*4202. Metal Mining.—Ventilation by Natural Draft and by Assisted Draft. Albert Williams, Jr. (Importance of ventilation in metal mines is less than in collieries, but too often overlooked. The sources of vitiation of mine air, special need of studying and utilizing natural draft, working rules and practical suggestions for controlling air currents underground are discussed). Col Eng–Feb. Serial. 1st part. 5500 w.

*4203. Wire Rope Haulage. T. E. Hughes (Read before the Ohio Inst. of Min. Engs. The writer shows the necessity of proper study of conditions in deciding on type, and that the avoidance of friction is necessary to secure most satisfactory and economical results). Col Eng–Feb. 2500 w.

*4204. Explosives for Coal Mines.—Their Classification, Composition and Gaseous Products of Combustion. Vivian B. Lewes (From Trans. of the Fed. Inst. of Min. Engs. A comprehensive study or the safest explosives for use in gaseous and dusty mines). ColEng–Feb 4500 w.

*4205. Prospecting for Gold—Gold Placers; How They are Worked. Arthur Lakes (Theories of the origin of gold sands and the history and distribution of gold placer deposits throughout the world. Illustrated by maps showing locations of gold deposits in Europe, Asia and Africa). Col Eng–Feb. Serial. 1st part. 2500 w.

*4206. Iron Ore Mining. Charles Dean Wilkinson (From the Year Book of the Soc. of Engs., Univ. of Minnesota. Systems of mining used in Minnesota iron mines). Col Eng–Feb. 1600 w.

4215. Ancient Coal Mining. Walter H. Mungall (Paper read before the British Soc. of Min. Students on some interesting facts from the historical records of Scotch coal mining). Eng & Min Jour–Feb. 15. 1500 w.

*4225. The Loire, Gard, and Creusot-Blanzy Coalfields of France (From the *Atlas* of the Comité Central des Houillères de France. General description of coal fields, composition of coals and economic conditions). Col Guard–Feb. 27. 2600 w.

*4227. Percussion Fuses and Their Suitability for Fiery Mines. J. van Lauer, *Oesterreichische Zeitschrift für Bergund Huttenwesen.* A comparison of advantages of various fuses is made, and the advantages of the friction fuse discussed). Col Guard–Feb. 7. 1100 w.

*4229. Simultaneous Sinking and Tubbing of a New French Pit. Léon Thiriart (Translated from *La Revue Universelle des Mines, de la Metallurgie, etc.* A very complete description with construction details fully illustrated). Col Guard–Feb. 7. 3600 w.

*4242. Sampling and Measurement of Ore Bodies in Mine Examinations. Edmund B. Kirby (A thoroughly practical article). Aust Min Stand–Dec. 28. Serial. 1st part. 3300 w.

*4250. The Use of Electricity in Mining Operations (The method of firing shots by means of an electric fuse is described and the method of making connections illustrated). Ir & Coal Trs Rev–Jan. 31. Serial. 1st part. 1400 w.

4275. Placer Deposits in New Mexico. Cecil A. Deane (The article describes the way in which the gold occurs in the several districts). Min Ind & Rev–Feb. 13. 2700 w.

4319 The Gold Fields of the Transvaal (This article is written in popular style and gives an interesting picture of native miners going to work, a zebra propelled stage coach, and a gold productive diagram from 1887 to 1895). Sci Am Sup–Feb. 22. 1400 w.

†4322. Notes on the Kaolin- and Clay-Deposits of North Carolina. J. A. Holmes (The paper treats of both the Kaolin deposits "in place" and the sedimentary clays, describing their method of occurrence and uses to which they are put). Trans Am Inst of Min Engs–Feb. 2000 w.

†4323. The Ore-Deposits of the Australian Broken Hill Consols Mine, Broken Hill, New South Wales. George Smith (The lode has a thickness of 18 inches with well defined walls and has been worked 1300 ft. A section of the deposits is given in connection with the description). Trans Am Inst Min Engs–Feb. 3400 w.

†4324. The Cycle of the Plunger-Jig. Robert H. Richards (A series of 41 curve diagrams representing the pulsations in the Harz, Crank, and Collom jigs, and the deductions that can be drawn from them. Interesting data are given as to the jig practice in a number of our prin-

cipal ore dressing works). Trans Am Inst of Min Engs–Feb. 2800 w.

†4325. The Theory and Practice of Ore-Sampling. D. W. Brunton (The subject is discussed from both a practical and theoretical standpoint. Tabular statements and diagrams are presented and formulæ derived). Trans Am Inst of Min Engs–Feb. 4000 w.

†4326. Mining Titles on Spanish Grants in the United States. R. W. Raymond (Considerations affecting the validity of a mining deed). Trans Am Inst of Min Engs–Feb. 3000 w.

†4327. Present Condition of Gold-Mining in the Southern Appalachian States (Discussion of the paper of Messrs. Nitze and Wilkens, containing additions and corrections). Trans Am Inst of Min Engs–Feb. 4800 w.

*4362. Notes on the Ore Deposits of the Malaga Serpentines (Spain). Fritz Gillman (Paper read before the Inst. of Mining and Metallurgy. A mineralogical description of the nickel and iron ore deposits). Min Jour–Feb. 15. 2500 w.

*4363. Cripple Creek Goldfield (Colorado). T. A. Rickard (General Description by the Colorado State Geologist). Aust Min Stand–Jan. 4. 1500 w.

4366. Transporting Mining Machinery. Ill. (Transporting an 800-lb. cam shaft through a timbered country to an Oregon gold mine). Min & Sci Pr–Feb. 15. 600 w.

4396. Manufacture, Use and Abuse of Dynamite. Harry A. Lee (A paper by the California State Commissioner of Mines, on the precautions necessary in handling and using dynamite). Eng & Min Jour–Feb. 22. 1600 w.

4417. The Burns Gold Mine, North Carolina. H. M. Chance (A brief description). Eng & Min Jour–Feb. 8. 800 w.

*4418. A Large Coal-Screening and Washing Plant (Description illustrated by plans and sections of plant). Col Guard–Feb. 14. 1400 w.

*4419. Colliery Explosions and Coal Dust. James Ashworth (Examination into the occluded combustible gases, the ignition point of coal dust, and the after damp in British mines). Col Guard–Feb. 14. 2600 w.

*4420. Apparatus for Experimenting with Firedamp. H. Schmerber, in *Le Génie Civil* (The apparatus is illustrated by detail drawings, and is intended to show the effect of various gases on the lamp flame). Col Guard–Feb. 14. 1500 w.

4437. Lighting Hydraulic Mines. Ill. W. W. Briggs (The use of incandescent lamps at night is described and their economy shown over bon fire illumination as being in the ratio of $3.18 to $11.50 per 12 hour shift). Jour of Elec–Jan. 600 w.

4458. An Interesting Example of Ropeway Practice (This ropeway conveyor handles 200 tons daily, at about 2½ cts. per ton, using 8 h. p., conveying the tailings about a mile. The special features are a 60° turn mechanism, and an automatic loader, both illustrated). Min & Sci Pr–Feb. 22. 900 w.

4459. Testing the Ores (The method usually employed of sampling the ores at the mines is briefly described). Min & Sci Pr–Feb. 22. 450 w.

*4469. The Mining Industry of the Dutch East Indies (A cursory view of the petroleum and gold industries). Bd of Tr Jour–Feb. 800 w.

*4514. Expedition in Search of Coal in the Districts Immediately South of the Zambesi. Charles J. Alford (An interesting account of the expedition giving the principal features and resources of the region). Min Jour–Feb. 22. Serial. 1st part. 3300 w.

*4515 Gold Mining in the Hauraki District, New Zealand. Henry M. Cadell (Abstract of a paper recently read before the Mining Inst. of Scotland. The counties and districts are noticed separately and much valuable information given concerning them). Min Jour–Feb. 22. Serial. 1st part. 2400 w.

*4517 The Future of the South African Mining Industry (The editor thinks that though affairs have a gloomy aspect now, the prospects for the future are quite reassuring though not very bright). Min Jour–Feb. 22. 1800 w.

4550. The Lake Harold Gold Mine (A brief illustrated description of a rich Ontario mine). Can Min Rev–Feb. 2200 w.

4551. Gold in British Columbia. R. C. Campbell-Johnstone (A brief review of the field). Can Min Rev–Feb. 3200 w.

*4559. The Use of Congelation in Mining Operations (From a communication by M. F. Schmidt, to the Société de l'Industrie Minérale, Saint Etienne. A condensation from the original exhaustive article which covers the entire field and deals with both the scientific and economic applications of this principle. Col Guard–Feb. 21. Serial. 1st part. 3700 w.

*4566. High Explosives in Mines (The report of the "Flameless Explosives" Committee to the N. of Eng. Inst. of Min. & Mech. Engs. The article gives the conclusions arrived at after exhaustive experiments). Prac Eng–Feb. 21. 900 w.

4567. Cyanide Process of Treating Gold Ores (The reason why cyaniding cannot be applied to Southern gold ores is because much of the gold is associated with iron pyrites which is dissolved by the cyanide to such an extent as to foul the solution). Tradesman–March 1. 1300 w.

*4613. A Study of Some Ore Deposits. F. D. Johnson (The first paper read at the inaugural meeting of the A. I. M. E. Discussion of the "indicator" and lode systems of deposits in Australia). Aust Min Stand–Jan. 30. 2800 w.

*4614. Concentration of Auriferous Sulphides in California (The milling plant of the Golden Gate gold mine at Sonora is considered a model of its kind, and a brief description is given). Aust Min Stand–Jan. 30. 800 w.

*4615. Methods of Mine Timbering (A detailed description of devices for various uses with cuts of a Black Hills gold mine). Aust Min Stand–Jan. 23. 2600 w.

4634. The Corral Hollow Coal Mines (Well illustrated description). Min & Sci Pr–Feb. 29. 200 w.

4635. Comstock Ore Sampling. John D. McGillivray (An enumeration of defects in practical sampling and an exposition of the unsatisfactory method employed on the Comstock lode). Min & Sci Pr–Feb. 29. 3200 w.

4636. Some Notes on "Crossings." Herbert C. Hoover (The crossing referred to is where the vein passes through some material differing from the country rock. Sections illustrating crossings through slate are given and the statement made that the vein continues usually on the other side). Min & Sci Pr–Feb. 29. 1200 w.

4637. North Carolina Gold Fields. J. J. Newman (The communication discusses the need of a central reduction plant and gives a map showing location of gold mines in ten counties, with tabular statement showing character and production). Mfrs Rec–March 6. 1200 w.

4655. The Hydraulic Gravel Elevator at the Chestatee Mine, Georgia. W. R. Crandall (Abstract of a paper presented at the Pittsburg meeting of the Am. Inst. of Min. Engs. The description of the apparatus is condensed and lucid and is illustrated by a section of nozzle and a cut of the general arrangement). Eng News–March 5. 600 w.

*4695. A New Spanish Coal Basin. Francis Laur (Translated from *L'Echo des Mines et de la Métallurgie*. Interesting particulars regarding a new coal basin in Old Castille, in the north of Spain). Col Guard–Feb. 28. Serial. 1st part. 2800 w.

†4698. The Design and Testing of Centrifugal Fans. H. Heenan, and W. Gilbert (Abstract of a paper read at the meeting of the Inst. of Civ. Engs. The results of tests made to determine the discharge and efficiency of fans, and their effect on the design of fan-blades and fan case). Ind & East Eng–Feb. 8. 900 w.

*4700. Victorian Gold Mining. Thomas Cornish (Misleading statements in prospectuses). Min Jour–Feb. 29. 1500 w.

*4711. The Transvaal: Its Mineral Resources. J. Logan Lopley (An excellent description, including statistics from the State Mining Engineer's report, and geological section of the deposits, and a map of the State). Knowledge–March 2. 3300 w.

Miscellany.

*4112. The Royal School of Mines (A series of toasts relating to mining delivered at the annual meeting of the alumni. The speeches are necessarily general and quite readable). Min Jour–Feb. 1. 10500 w.

*4113. The Useful Minerals of Tasmania. A. Montgomery (Paper read before the I. M. E., Hobart meeting. The minerals are mentioned as they occur in the several geological formations). Min Jour–Feb. 1. Serial. 1st part. 3000 w.

*4241. The Manufacture of Sulphuric Acid from Auriferous Pyrites. Walter J. Studds (A suggestion for working up concentrated tailings). Aust Min Stand–Dec. 28. 1500 w.

*4255. The Coal Ports of the United Kingdom. Cardiff. Ill. (The shipments from this South Wales port increased in the past 56 years from 4000 to 12,000,000 tons annually. The necessary improvements consequent are described in the article). Ir & Coal Trs Rev–Jan. 31. Serial. 1st part. 4900 w.

†4335. Corundum of the Appalachian Crystalline Belt. J. Volney Lewis (Principally the result of work of the N. C. Geol Surv. The paper treats of the geology, associated rocks, mineralogical occurrence, mining methods and literature of corundum). Trans Am Inst of Min Engs–Feb. 20000 w.

†4336 Recent Phosphorus Determinations in Steel (Discussion of the paper of Mr. Thackray. Comparison of results from six methods. Mr. Blair thinks that check assays by different methods are better than duplicate assays by the same method). Trans Am Inst of Min Engs–Feb. 1000 w.

†4337. The Assay of Silver-Sulphides (Discussion of the paper of Mr. Furman bringing out the fact that iron nails are not only unnecessary but may occasion loss in assays of rich sulphide). Trans Am Inst of Min Engs–Feb. 700 w.

†4338. The Monazite Districts of North and South Carolina. C. A. Mezger (A general description of deposits and method of working). Trans Am Inst of Min Engs–Feb. 2500 w.

†4339. The Phosphates and Marls of Alabama. Eugene A. Smith (Geological relations with description of deposits). Trans Am Inst of Min Engs–Feb. 4300 w.

†4340. Notes and Recollections Concerning the Mineral Resources of Northern Georgia and Western North Carolina. William P. Blake (Gold, silver, copper, zinc, iron, coal, building stone and other mineral occurrences are described). Trans Am Inst of Min Engs–Feb. 5400 w.

†4341. Folds and Faults in Pennsylvania Anthracite Beds (Postscript). Trans Am Inst of Min Engs–Feb. 400 w.

†4568. The Mineral Deposits of Eastern California. Harold W. Fairbanks (The economic geology of the gold and the silver and lead deposits with discussion and conclusions). Am Geol–March. 5600 w.

4602. Notes on Conveying Belts and Their Use. Thomas Robins, Jr. (Read at the Pittsburg meeting of the Amer. Inst. of Min. Engs. An excellent paper giving the best practice and also illustrations of conveyor pulleys and feeding arrangements). Ir Age–March 5. 2800 w.

†4607. On Trinidad Pitch. S. F. Peckham and Laura A. Linton (An excellent description of the Trinidad pitch lakes with map and a full discussion of the analysis of the asphalt and tabulated analyses). Am Jour of Sci–March. 5000 w.

*4694. Welded Steel Mains and Joints. J. G. Stewart. (Paper read before the Manchester Assn. of Engs. The advantages of steel and of cast iron pipes are discussed, especially when transportation is a factor. The article is illustrated by 9 views and sections of joints used in steel pipes). Ind & Ir–Feb. 28. 3500 w.

MUNICIPAL ENGINEERING

Clarification of Sewage at Richmond, England.

THE process of clarification at Richmond (on the Thames river), Eng., seems to be a very effective one. It is described in the following abstract of an article in *Machinery* (London, Feb. 15).

Worthington pumping engines capable of dealing with five million gallons of sewage daily, when this capacity is required, are employed for moving the sewage through the various stages. Before the sewage reaches the pump chamber, it has to pass through a strainer of iron rods, which prevents the passage of bulky matter in the refuse. Then it flows in a continuous stream into the pump chamber, and there is charged with milk of lime from the chemical vats. The process of pumping thoroughly blends the sewage and the lime. The mixture then flows from the delivery pipes of the pumps into a channel for the treated sewage, where another iron bar strainer intercepts any heavy matter that may have escaped the first. Then it is again charged with sulphate of alumina and carbon, and is carried to the tanks by a fresh channel, which communicates with the first by means of valves that can be opened according to requirement. The sewage rises to the level of a weir forming the outer side of the channel, and overflows it until the tank is filled or the valve closed. By the time the tanks are filled the bulk of the solid matter has been precipitated, and the effluent water flows away over weirs at the other end of the tanks. At this stage of the process the water has been sufficiently clarified to be discharged into the river, to which an outlet is provided opening into its bed in mid-stream at its greatest depth. But, in order to obtain a higher purity, it goes through a course of filtration through filter beds composed of a surface of agricultural soil, on which grass is grown, with layers of gravel, sand, and carbon. The effluent water passes gradually through these filter beds, and reaches the river outlet with a degree of purity which, while it would not justify its use for domestic purposes alone, yet, when mixed with the river water, is perfectly drinkable. It is as clear as crystal, and runs over the weir with the limpidity of a trout stream in dry weather. A few hours before, it was pouring into the pump room, a volume of black sludge, almost appalling to the sight. It may happen in times of high spring tide, when the river is filled with land water, that the discharge from the filter beds cannot take place by gravity. When that is the case, steam pumps are set to work to pump the effluent water out.

The solid matter, if it can be called solid, which is precipitated to the bottom of the tanks, is from two to three inches in depth, and a certain depth of water is allowed to remain above the sludge to the extent of six or seven inches. As the bottoms of the tanks have a slope of one in sixty, the precipitate, with the overlying water, passes gradually into a fresh chamber, where another process of precipitation takes place, and the water which remains at the top of the sludge is drawn off, repasses into the pump chamber, is mixed with the sewage again, and treated as fresh sewage. Then the sludge, having lost much of its moisture, is lifted into iron receivers by pumps, where lime is added to it again to make it more amenable to pressure, and rams are employed to press the water out of it and force the solid matter into the presses. The water goes back again into the pump chamber, and the sludge is pressed into solid cakes, measuring 3 ft. square by 1½ in. thickness, and taken from the presses.

By this time it is as free from noxious smell as the effluent water is from impurity. It can be stored in heaps in the open air without creating nuisance, and it possesses a certain value for manurial purposes. In the main drainage works,

the sludge, once pressed, is placed on trucks and carted down to the quay, where it is run on board a barge and carried away as a marketable article. But the sludge, it must be distinctly understood, represents no return to the board of sewerage or the ratepayers. The contractor has to be paid for taking it away. He disposes of it down the river, in Essex or Kent, for the best price he can get; and there are lands to which it is specially suited, whose owners or occupiers are glad to have it. It may be added that the sludge, when not pressed out to the fullest possible extent, is yet found a very valuable material for raising low-lying lands, filling up ditches and ponds, and otherwise levelling fields.

Supply of Sea-Water to London.

FOR a long time the use of sea-water in cities for watering streets and for fire extinguishing has been recognized as an available future resource when the supply from other sources ceases to be sufficient both for these purposes and for potable and domestic use. It is probable that some American seaboard cities would already have used sea-water in this way, had there not been up to the present time sufficient water attainable from other sources at less cost. But little thought is required to convince any one that the expense of such a system for a city like New York would be enormous both in first cost and in subsequent operation, as a separate system of distributing mains and large pumping engines would be needed. The effect upon the public health of cities of the use of sea-water for street-watering has been experimentally determined, so that in any case we may predict in advance that the use of pure sea-water will be salutary. It is true that streets and pavements become more or less saturated with the crude salts dissolved in the water, but the effect of this addition to the complexity of street-dust when inhaled constantly has not been found detrimental. The chilliness of pavements in winter during snowfall is undoubtedly increased, and this is about the only objectionable concomitant. However, the experiment is to be tried in London on a much larger scale than has hitherto been attempted. The details of this scheme are given in a paper read by Mr. Frank Grierson before the Society of Arts, reprinted in *The Architect and Contract Reporter* from the *Journal* of that society.

Nine or ten millions gallons are to be supplied daily. The intake is to be opposite Lancing, between Brighton and Worthing, the sea-water having great purity at that point.

The sea-water will first be pumped into a reservoir or settling-tank at Lancing, the bottom of which is about ten feet below high water; this reservoir will have a capacity of ten million gallons. The water is thence forced to a reservoir situated near the summit of Steyning Round Hill. The pumps and machinery are all situated alongside the reservoir at Lancing. This is, therefore, the only pumping station in the whole system. It adjoins the railway, and is provided with its own sidings for coal, &c. The Steyning reservoir will be situated nearly five hundred feet above high-water level, and will have a capacity of ten million gallons. The sea-water will flow thence, by gravitation, to a third reservoir at Epsom, over two hundred feet above high-water level; this also will have a capacity of ten million gallons. From this reservoir the sea-water will flow, by gravitation, to London, where it can be delivered under the pressure due to this head which is greater than that which most of the water companies command. The sea-water will be conveyed in mains the whole distance, and, as there will be two days' supply in the Steyning and Epsom reservoirs together, the mains will be always full. It is a practical impossibility that they should ever be frozen.

The first place to make habitual use of sea-water was Ryde, England, more than forty years ago. Tynemouth was the next, in 1872. Barrow-in Furness, Birkenhead, Blackpool, Bootle, Bournemouth, Falmouth, Great Yarmouth, Grimsby, Gosport, Harwich, Littlehampton, Plymouth, Portsmouth, Shoreham, South Shields, Torquay, Weymouth, and other places have since followed those examples. It is found that once

watering with sea-water is equal in efficiency to twice or even thrice watering with fresh water. Sea-water keeps the road-surface moist for a long time, but without slush. It hardens and binds macadam roads, and forms a preservative crust which prevents dust from rising. It is the one thing needed to make wood-paving perfect, as, by retarding the decomposition of the street-refuse, it will effectually prevent the annoyance of any smell arising therefrom, of which annoyance public complaint has occasionally been made; when wood-paving has displaced granite and macadam, this is a feature worth mentioning. The proportion of salts in sea-water is about 3½ per cent., or, more exactly, 36½ parts per 1,000. Of these, nearly 30 parts are chlorid of sodium, or common salt, and about 3½ parts are chlorid of magnesium; it is owing chiefly to the deliquescence of these salts that the roads remain sufficiently moist for so long. A ton of sea-water contains about 220 gallons, from which are deposited 80 pounds of salts. A water-cart will spread a ton of water over a surface of from 1,900 to 2,000 square yards.

The cost of sea-water for street-watering in London probably will be less than that of fresh water; but, were it even the same, it is claimed, the advantage and economy of sea-water would be great, because the quantity used would not exceed half the present quantity used; the cost of distribution, horse-wear, etc., would be correspondingly reduced, and the roads would last longer in sound condition, and cost less to repair. This is the recorded experience of the places which have used sea-water. In the hottest weather, when water is most required, there is now too often a difficulty in getting sufficient water for the streets, whereas the sea could never run short.

The use of sea-water for flushing sewers is found to be decidedly beneficial; decomposition is retarded, and the sewers are kept cleaner and become more wholesome when salt-water is present in them. The borough surveyor of Great Yarmouth, for instance, stated that his experience showed that the advantage of being able to flush the sewers with sea-water was alone worth the whole cost of the works for the supply of sea-water for all purposes. His experience is that the effect of flushing with salt water has been to thoroughly cleanse the sewers, and that no nuisance from its use has been created, while, owing to its greater specific gravity, he considers it more valuable as a flushing agent. Its effect in the Yarmouth sewers has been to reduce, and, in fact, almost entirely to prevent, the generation and accumulation of sewer gas. Sewers that could not be entered by the sewer men until the manhole covers had been opened several hours can now be entered by them, and have been entered, without any inconvenience, immediately on the removal of the manhole cover.

Contract Work Not Always Desirable.

IN an excellent editorial *The Engineering Record* (Feb. 15) notes a growing tendency on the part of small corporations and private owners to cut loose from the contract system in construction. What is here meant by the contract system is the method of competitive proposals for constructive work. Any one who undertakes to perform work under any sort of agreement as to price, time limit, etc., is, strictly speaking, a contractor, and his work is contract work; but, in general, contract work is understood to be work competed for in price before its allotment. This system has been attended with many evils, but it also has advantages. The advantages and evils have often been debated, the conclusion being that the system is the only one so far found which is generally applicable to government and municipal construction, although its purpose is too often defeated by official favoritism and corruption.

The *Engineering Record* says: "A New York builder is frequently given *carte blanche* to build an important building, the owner often insisting that he only shall do the work, the price paid being cost plus an agreed percentage for supervision and profit. The Broadway Cable Railway was built in this way. This condition arises partially from a special confidence in the particular contractor, but mainly from the fact that the difficulties of estimating closely on complicated work are so great

that the bids will vary greatly, and the chances are about equal that the lowest bidder will be one whose ability is not well recognized, or who, from inexperience or recklessness, will take great chances and either delay the work, or, having named too low a price, slight it in the endeavor to come out ahead of his contract, or fail absolutely to carry it out, involving delay and complications in reletting.

"There are many classes of work on which it is almost impossible to estimate closely as to time as well as cost; in the case of the Broadway Cable road it was absolutely impossible to tell what difficulties or delays would be met, and, if bids were invited, they would certainly have varied greatly, and the lowest would probably be vastly in excess of the actual cost of the work, to enable the contractor to cover the chances involved.

"In the construction or reconstruction of large and valuable buildings the loss of rentals and interference with business becomes so great that excessive prices can well be paid to secure prompt results; for this reason the work on several of our great buildings has been pushed night and day at greatly increased cost. By the successful execution of such extensive and difficult work some contractors and contracting firms have secured the confidence of capitalists to such an extent that they can command their own terms and select their own work."

With reference to the general impression that contract work must necessarily be the most economical, it must be admitted that it is not groundless; and yet there may be conditions in which the very opposite would be true. It is not the ultimate cost of a piece of work that interests a contractor, so much as the prospective profit; and we think there would be few honest men who would not prefer to do a piece of work in the best manner, when assured a reasonable profit, rather than take the risks of loss which weigh against the chance of profit in contracts given on the competitive system. The following quotation is suggestive:

"The monopoly of large and difficult work, which the more powerful contracting firms deservedly possess, make it more difficult, perhaps, to secure competent men to undertake the smaller works, while at the same time it leaves room at the bottom of the ladder for the new and less wealthy contractors, who often take as much or greater interest in the small jobs as the more prominent contractors do in the large ones. A corporation with much small work on hand, embracing several classes of work in each job, has, to our knowledge, found it wise and economical to divide the work. Its engineers and architects undertake the task of connecting the several portions, and keep peace and harmony, so to speak, between the several tradesmen; the result is that a saving is effected of from ten to thirty per cent. in the cost of the work, which, under the older system of general contracts, would go to the general contractor."

The system is both convenient and economical. In many operations owners would consult their best interests by selecting a reliable contractor and allowing him a reasonable profit on cost.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Municipal Engineering in the American, English, and British Colonial Engineering and Municipal Journals—See Introductory.

Gas Supply.

*4090. The Standards of Light. W. J. Dibdin (Reviews a report made by a committee of the Board of Trade, and given after three years of careful work, recommending the adoption of Harcourt's pentone standard as preferable to any and all others that have been used or proposed. The faults of the other standards are impartially stated. Long discussion by the members of the Soc. of Arts). Gas Wld-Feb. 1. 7800 w.

*4106. Incandescent Gas Light Patents (Editorial review of important decisions of the German Patent Office. The Auer patents are sustained but their claims have been restricted. A patent to Rudolf Langhaus for the electrolytic production of an incandescent body for gas lighting was allowed). Engng-Jan 31. 700 w.

4141. The Truth About Acetylene Gas. Albert Stetson (Severely criticising the statements made in the paper read by John C. McMynn). Elec-Feb. 12. 2800 w.

We supply copies of these articles. See introductory.

*4307. A Gas-Meter Testing-Station (A sketchy description of equipment and methods in the testing-station, London, Eng.) Jour of Gas Lgt–Feb. 11. 2000 w.

4472. Incandescent Gas Light Patents. (Special correspondence of the Eng. & Min. Jour. Review of recent decisions of the German patent office in cases involving incandescent gas lighting patents). Eng & Min Jour–Feb. 29. 2300 w.

*4581. Inaugural Address of A. F. Browne, before the So. Dist. Assn. of Gas Engineers and Managers (Discusses the topics of labor-saving machinery, outside help; carbonizing coal in bulk; enrichment of hydrocarbon vapors; the question as to whether these vapors reside in the gas or in the tar; enrichment experiments; lime purification; automatic meters and gas stoves). Gas Wld–Feb. 22. 4800 w.

*4582. Inaugural Address of W. R. Cooper, before the Midland Assn. of Gas Managers (Topics discussed are the retort and its furnaces; condensation and the extraction of tar; the past and present of purification; carburetted water gas; electricity no longer a bogey; and the advantages of association). Gas Wld–Feb. 22. 6000 w.

4605. Lighting by Holophane Globes. F. Guilbert (Translated from *L'Eclairage Electrique*. An able and exhaustive scientific analysis and explanation of the action of these globes with numerous diagrams, by which the action is shown to approach very nearly the ideal photometric curve in the distribution of light). Pro Age-March 1. Serial. 1st part. 2500 w.

4606. On the Poisonous Properties of Acetylene. Dr. Rudolf Rosemann (From the *Journal of the Pharmacological Inst. of the University of Greifswald*. Describes minutely, from notes of observations made at frequent intervals, the effects of acetylene upon vital functions, when inhaled by animals Twelve experiments were made. In one of these, thirty-two observations were taken of the vital conditions of the animal, before death was produced). Pro Age–March 1. 7000 w.

4702. The Production of Cyanide in Gas Works (Illustrated description of process and apparatus). Am Mfr & Ir Wld–March 6. 700 w.

4703. The Development of Candle Power. W. S. Allen (Paper read at the twenty-sixth annual meeting of the New England Assn. of Gas Engs. Treats of the demand for higher candle-power and some of the less well known methods of obtaining higher candle power in gas, with discussion). Am Gas Lgt Jour–March 9. 3300 w.

4704. Acetylene Gas. Walter R. Addicks (Describes the manufacture of calcium carbide as carried out at Spray, N. C. Considers the qualities of the product, and the possibilities, as well as practicabilities of acetylene as a factor in the manufacture of gas). Am Gas Lgt Jour–March 9. 10000 w.

Sewerage.

*4146. The Present European Practice in Regard to Sewage Disposal. Allen Hazen (A general review of the subject). Jour of Assn of Eng Soc–Dec. 8000 w.

4216. Underdrainage Purification Plant, Sewerage System of South Framingham, Mass. (Illustrated description). Eng News–Feb. 13. 1100 w.

4219. The Dislocation of a Brick Sewer in Soft Ground, at Lynn, Mass. (Description, with engraving, and proposed remedy). Eng News–Feb. 13. 400 w.

4301. Report on the Sanitary Needs of Cleveland, O. (An interesting and instructive document). Eng Rec–Feb. 15. 1200 w.

4473. Gagings of the Dry Weather Flow of Sewage at Des Moines, Ia. J. A. Moore and W. J. Thomas (A compilation of data from records of various sewer-flow gagings in American cities. Illustrated description of apparatus for gaging flow, and a diagram of hourly pumpage and sewer-flow at Des Moines, June 30 to July 16, 1895). Eng News–Feb. 27. 3800 w.

4478. The Operation of the Brockton Sewage Filter Beds in 1895 (Information on the subject of sewage filtration derived from observation of the results attained in the filter beds at Brockton, during the past year. The disposition of the sewage, without offensive odors, is as yet not satisfactorily effected at Brockton). Eng News–Feb. 27. 2300 w.

*4504. The Richmond Drainage and Sewage Works (A popular description of the plant and process of treatment). Mach, Lond–Feb. 15. 2500 w.

*4534. Sewage and Zymotic Poisons. James Hargreaves (Read before the Liverpool Polytechnic Society. Poisons are divided into three classes—elemental, organic or quasi-organic, and organized, self-propagating or parasitic poisons,—this class being that for which sewage supplies the elements for propagation, and which therefore includes the zymotic poisons with which the author deals. Methods by which these poisons are propagated and diffused, and means for their prevention are described). San Rec–Feb. 21. 3200 w.

*4535. System of Syphon and Refuse Holder for Street Gullies (Illustrated description of a French water trap system whereby odors and gases from sewers are prevented from gaining access to the air in streets). San Rec–Feb. 21. 1300 w.

Streets and Pavements.

4498. Paving Country Highways. William S. Williams (The author discusses the application of brick paving to public highways, and finds it good). Clay Rec–Feb. 26. 900 w.

*4548. Cleaning and Watering of Streets in Paris. Alfred Perkins Rockwell (Extract from "Roads and Pavements in France," just published by John Wiley & Sons, New York. Subject is discussed under these heads: (1) The removal of mud and household refuse, which is done by contract. (2) Sweeping and watering, done exclusively by the street-cleaning department, except that sand and the use of some sweeping machines are obtained by contract. (3) Removal of snow and ice. Description of means and methods are given). Pav & Mun Eng–March. 1300 w.

4591. Needed Legislation on the Drainage of Public Highways. B. B. McGowen (Suggestions which the writer thinks would secure good roads the year around; followed by discussion). Brick-March. 2500 w.

4593. Paving Country Highways. Captain Williams (Favoring the movement). Brick-March. 1100 w.

4594. Brick Pavements the Best. M. H. Underwood (In favor of vitrified brick, laid on a concrete foundation). Brick-March. 3300 w.

Water Supply.

4152. The Montreal Water-Works. John Kennedy (History and general description, including the aqueduct and pumping machinery). Can Eng-Feb. 8000 w.

4220. Future Water Supply of Greater New York. (An exhaustive editorial discussion of what is growing to be a serious problem. It is computed that by the year 1920, no less than 600,000,000 gals. daily will be needed, and there is a strong probability that the daily demand may reach 1,000,000,000 gals. The supply and distribution of this enormous amount of water will demand the highest skill and forethought). Eng News-Feb. 13. 2400 w.

4302. The Newton, N. J., Water-Works (Illustrated detailed description). Eng Rec-Feb. 15. 3300 w.

†4349. Notes on the Underground Supplies of Potable Waters in the South Atlantic Piedmont Plateau. J. A. Holmes (The topic of the relative purity of surface water and that from deep wells is first discussed and the limited availability of deep artesian wells is then presented, and the tube-well system is commended as adapted to the plateau in question). Trans Am Inst of Min Engs-Feb. 2800 w.

*4377. The Purification of Water by Means of Metallic Iron. F. A. Anderson (A good popular description of the process as carried out at different installations in various cities in Europe). Jour Soc of Arts-Feb. 14. 8000 w.

4394. The Nashua Aqueduct (Illustrated detailed description forming part of the works intended to supply the metropolitan district of Boston). Eng Rec-Feb. 22. 2400 w.

4476. The Water Supply and Water Consumption of Philadelphia (Graphic representations of water supply and consumption and of various estimates of future consumption, with explanatory text). Eng News-Feb. 27. 1400 w.

4479 Nordberg Compound Pumping Engine, New Kensington, Pa (Illustrated detailed description). Eng News-Feb. 27. 2500 w.

Miscellany.

*4086. Standpipes for Fire Protection and Street Flushing. Louis L. Tribus (Describing a method of dispensing with steam fire engines by the substitution of hose companies, and at the same time increasing the safety of property and life). Eng Mag-March. 3000 w.

*4117. The Supply of Sea-Water to London. Frank W. Grierson (A paper read at the meeting of the Soc. of Arts. It gives a general description of the plan of supply, with remarks on its use for municipal purposes, hospitals, schools, hotels, residences, etc., showing the saving of fresh water, and a summary of the advantages). Arch, Lond-Jan. 31. 3300 w.

4223. Reports on an Additional Water Supply for Brooklyn, N. Y. (Difficulties experienced in keeping up supply to meet increased demand. Editorial review of Mr. De Varona's report on what is known as the "Long Island Plan," and of Mr. Worthen's reports on the "Housatonic or Ten Mile River Plan," and the "Ramapo and Walkill Plan," followed by a comparison of these three plans, and comments by Mr. Alfred T. White). Eng News-Feb. 13. 5000 w.

*4288 Investigation of Electrolysis at St. Louis (From the annual report of the supervisor of city lighting at St. Louis, telling of steps taken to learn the extent and to prevent electrolysis). St Ry Rev-Feb. 15. 450 w.

4300. Contract Work not Always Advisable (A good editorial on the growing tendency to avoid the contract system). Eng Rec-Feb. 15. 900 w.

*4308 The Welsbach Patents in Germany (Summary of the official decision in the nullity suit). Jour Gas Lgt-Feb. 11. 2700 w.

4346. The Final Disposition of the Wastes of New York City (Abstracts of advance sheets of a forthcoming report, on the disposal of garbage, street-sweepings, store and other refuse of New York, by Col. G. E. Waring, Com. of Street Cleaning). Eng News-Feb. 20. 600 w.

4392. Franchises for Small Municipalities (Editorial. The carelessness with which franchises for small municipalities are granted, and the resulting evils, are the burden of this able article). Eng Rec-Feb. 22. 900 w.

4474. An Ordinance to Prevent Electrolysis of Water and Gas Pipes at Richmond, Va. (Full text of an ordinance approved Jan. 23, 1896. Will be a guide to similar legislation in other municipalities). Engng News-Feb. 27. 1400 w.

*4546. Production of Asphalt in the United States (Statistics compiled from the sixteenth annual report of the U. S. Geol. Surv). Pav & Mun Eng-March. 800 w.

*4547. The Contractor's Fair Profit. J. H. Burnham (Abstract from address before Illinois Soc. of Surv. & Engs. The fact that contractors often fail to secure a fair profit is noted, and reasons for such failure are given. This is followed by hints intended to help in securing the opposite result). Pav & Mun Eng-March. 2300 w.

*4549. Essential Features of a Park System (Abstract of a report suggesting plans for a park system, in which essential features are outlined by a distinguished firm of landscape architects). Pav & Mun Eng-March. 2500 w.

†4579. On the Use of Acetone in the Technical Analysis of Asphaltum. S. F. Peckham (A comparison of tests of acetone and of petroleum ether in parallel experiments, with a statement of results from which the author concludes that acetone cannot be made an equivalent for petroleum ether in the technical analysis of asphaltum). Jour Fr Inst-March. 1200 w.

RAILROADING

Articles of interest to railroad men will also be found in the departments of Civil Engineering, Electricity, and Mechanical Engineering.

The Sand Track Derailer.

IT sometimes happens that locomotives become unmanageable and run off; or that signals are disregarded; or that brakes refuse to work; or that from similar causes trains crash through open draws or collide with other trains. Derailing-switches prevent such accidents on side-tracks, but the following method from the *Scientific American Supplement* (March 7) fills a decided void in main-track devices:

"As is known, there are in use on the English railways, for the protection of main lines, switches, throwing from the main line cars which come from side-tracks at improper times. Such switches, called 'throw-offs,' are connected with the signal in such a manner that the latter cannot allow the passing of a train to the main line, the throw-off switches sending it into the sand on ballast. In case of a car moving on the siding in the direction of the main line, it will be thrown off the main line in time to be stopped by the resistance of the ballast.

"This way of stopping cannot be employed for trains on main lines, because it would bring about destruction not less shocking than that which it would be intended to prevent. Therefore it is necessary to make the leaving the main rails an entirely safe measure before it can be recommended as a means of safety.

"This may be done by guiding the train to be stopped, not into the ballast, but on a separate track, the rails of which are covered with a layer of sand; the switch leading to this track to be coupled with the signal before which, when it stands at danger, the train should stop. A second switch may serve as an outlet into the main track to avoid backing the stopped train. This safety siding, being always covered by a layer of sand, is not dependent for its efficiency on the engine runner, nor on an apparatus for strewing sand, nor on the watchman for throwing impediments on the rails.

"Tests have been made of the effect of the sand tracks on a track having a grade of 1 in 100. Wooden guard sleepers are placed between the rails, leaving a gutter for the wheel flanges and rising five centimeters (=two inches) above the level of the rails. These guard sleepers serve both to secure the wheels against leaving the rails and to level the sand layer. The cars were set in motion by a shunting engine, and accelerated by the grade of 1 in 100.

TABLE OF RESULTS OF TRIALS.

No.	No. of cars.	Veloc'y meters per second.	Distance in sand, in meters.		P'tential en'gy.	Coefficient of resistance. f
			a	b		
1	2 empty	3.75	7	17.6	1.082	0.0880
2	8 empty	5.882	13.6	72.0	2.841	0.066
3	10 loaded	7.692	45.0	117.2	4.422	0.0543
4	10 loaded 3 empty	8.823	36.4	130.6	5.638	0.0675
5	9 loaded	10.0	78.2	142.6	6.870	0.0622
6	9 loaded	12.5	101.0	165.0	10.113	0.0760

"The thickness of the sand layer was 5 cm. for numbers 1 to 4, and 8 cm. for numbers 5 and 6.

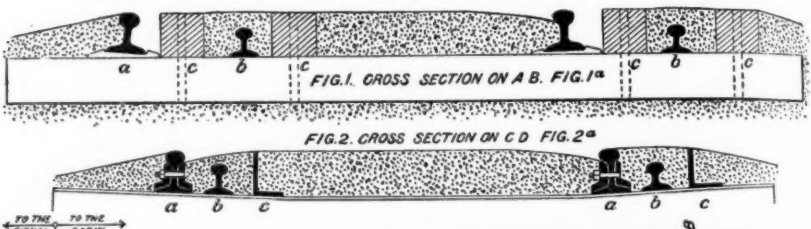
"As an example of the manner of calculation of the coefficient, we may use the first trial.

"Example: The empty cars with the velocity of 3.75 meters per second came to a standstill after having run in the sand track with the first axle a distance of 17.6 meters, with the last one 7 meters; the mass of the rotating parts considered as at the circumference of the wheels was 16 per cent. of the entire mass of the cars (axles and wheels included); what was the friction?

"Solution: By substituting the given numbers in the equation we get

$$f=\frac{0.075+\frac{17.6}{100}+\frac{1.16\times 3.75^2}{2\times 9.81}}{\frac{7+1.7\times 6}{2}}=\frac{1.082}{12.3};\quad f=0.088.$$

"From all the trials it has been proved that the retardation in the sand track is quite continuous and without any jerk.



KOPCKE'S SAND TRACK.

The buffers are pressed in gradually, and there was never remarked any tendency to lift an empty car placed between loaded ones, although there was often, by reason of the load, considerable difference of height of the buffers.

"Tests were also made during a cold spell with 10° below zero Centigrade (= + 14° F.)The sand layer of 8 cm. thick was frozen after having been sprinkled, forming a middling solid mass. Under these circumstances the sand track worked well, as the cars (7 empty and 1 loaded) ran into it without dangerous acceleration."

The sand best adapted for this is one which will not pack. The article includes other problems and formulæ for which space cannot be here given.

Profits of American and British Railways.

IN an editorial, *Engineering* (London, Feb. 14) discusses some of the causes which have made American railway securities such poor dividend-payers. The comparison is interesting as coming from good authority and being derived from accurate reports. We abstract some of the most interesting parts:

"The total mileage in the United States is 180,000, and the probabilities are that, in view of the low dividends, the additions each year will be less, for the lowness of the return on existing lines is more operative on the public mind than sanguine estimates of probable gain from new lines. It is true that there is only one mile of railway to 20 square miles of area, whereas in Britain we have one to 5.8 square miles. But this standard of comparison, so often adopted, is misleading. It were better to consider population and trade. In Britain there are 1,846 inhabitants per mile, and in the States barely 350, while the value of foreign trade, imports and exports, works out to over £30,000 per mile of railway in Britain, and to £1,900 per mile in the States. Of course the consumption of home products is an element in the consideration, but it must be remembered that the population of the United States is not double that of the United Kingdom, while the railway mileage is nearly nine times.

"The railway results themselves seem to show benefit to the trader rather than the shareholder, no matter from what standpoint these are examined. The interest paid on stock last year was 1.64 per cent.,—10 years ago it was 2¾ per cent.,—whereas in this country the return on ordinary capital is equal to 3⅛ per cent. The United States is not by any means so compact a country as this, but, at the same time, it should be remembered that this reason makes our roads the more expensive, so that the average capital per mile in this country is nearly five times as great as in the United States. In other words, each mile in this country must show a net

profit five times as great as in the United States to pay the same dividend. As a matter of fact, each mile in this country earns in net profit nearly £1,800, against £362 in the United States. But the difference in the gross earnings per mile open is not so great, being in the United States £1,217, while in this country it is £4,000, so that it will be recognized that our system is worked more successfully. In other words, 43 per cent. of our total receipts is profit; in the States barely 30 per cent. is thus retained."

Speaking of the passenger traffic, he says that "it is somewhat interesting to note that, although the total length of railroad in the States is 8½ times that in this country, the passenger train-mileage is not double. In other words, each mile of railway in this country is, on the average, traversed 8,600 times in the year by passenger trains, while in the States it is only covered about 1,900 times. This is, of course, due to the number of passenger trains in the far west seldom exceeding four per day; and in many cases a passenger car is only attached to the freight trains; so that it will be at once apparent that British conditions cannot obtain.

"The average fare per mile does not differ very much, but is rather less in the United States. There it is 1d. (2.03 cents) per mile, but in the more important districts ¾d. only. In this country the third-class passenger predominates to such an extent as almost to make the extra charge on first- and second-class passengers inoperative in effect, so that it may be taken that the rates are about the same.

"Our goods traffic receipts per mile of road is enormously greater,—£2,280 against £800. Again, our volume of goods traffic per mile of road is greater, being 15,500 tons against 3,848 tons in the States. It will be recognized that the difference is greater in volume than in receipts, indicating that in the United Kingdom the revenue is less per unit of volume than in the States. The fact that the average haul of each unit of volume is much greater in the States than here more than accounts for this. Our freight train mileage per mile of road is 7,150 against 2,700 miles in the States, but our total excludes mixed trains, which are ranked separately in the board of trade return. In other words, considered per mile of road, Britain runs three times the number of trains for four times the volume of traffic, and receives less than three times the gross revenue for goods. The average rate is notoriously higher, the haul is very much shorter. The average receipts per ton per train-mile in the States are .425d., and the average length of haul 121.89 miles. The latter in this country is far less. The receipts per goods train-mile are 73.62d.; in Britain, excluding mixed trains, 70d. Each United States train-mile represents 173 ton-miles at .42d. per ton. Similar figures are not given in the board of trade return. But it is very evident that the rates in the United States are much lower, so that the railways have to undertake heavier duty to make the gross revenue per train-mile the same.

"Including all revenue and all train mileage, the receipts per train-mile are in the United States 5s. 5¼d., in the United Kingdom 4s. 9½d.,—a difference of 7¾d. per train-mile. But this involves heavier duty in the United States in greater proportion than is indicated by the receipts, not only for the locomotives, but more especially in terminal charges, notwithstanding the long haul. And this in some measure accounts for the fact that in the States 70.24 per cent. of the revenue is absorbed in expenses. This is some 10 per cent. higher than in any of our Australian colonies, where the conditions are as unfavorable as in the States. In Britain, where legislation adds many costly conditions, the percentage has never exceeded 57. The result is that, instead of getting a net profit per train-mile of 2s. 1d., the United States railways only obtain 1s. 7½d. In other words, it costs them 1s. more for each mile run by a train."

Road-bed Specifications.

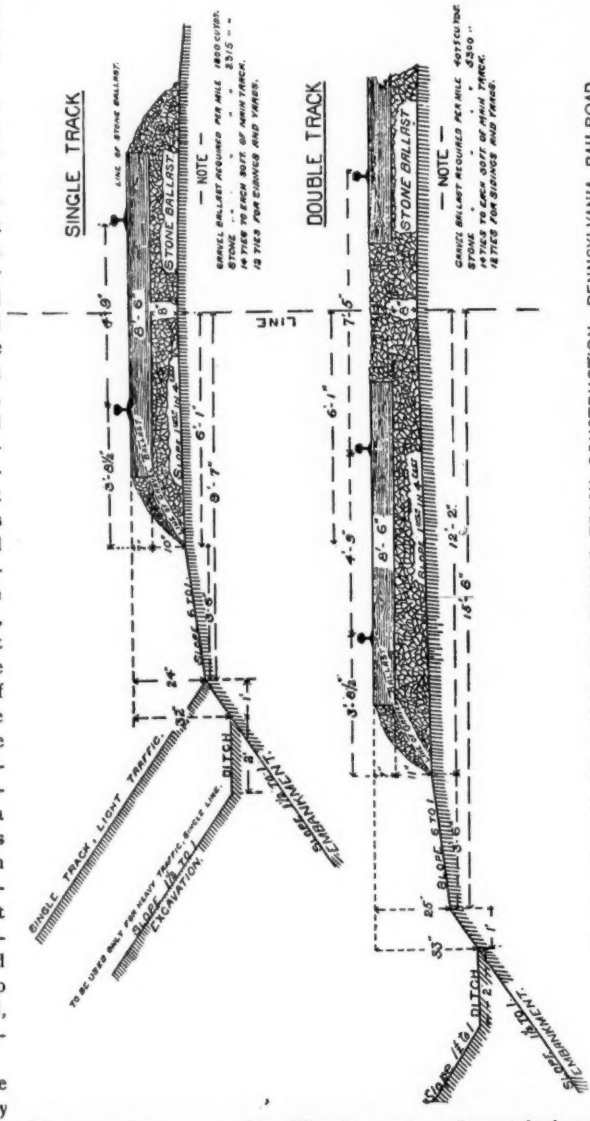
IN discussing the subject of street-railway roadbeds, Mr. Mason D. Pratt, in the *Street Railway Journal* (March), gives the specifications of the Pennsylvania Railroad as a good index to what a good road-bed

should be and as a basis for similar street-railway specifications.

"*Road bed.*—The surface of the road-bed should be graded to a regular and uniform sub-grade, sloping gradually from the center toward the ditches.

"*Ballast.*—There shall be a uniform depth of from six to twelve inches of well-broken stone or gravel, cleaned from dust by passing over a screen of one-quarter inch mesh, spread over the road bed and surfaced to a true grade, upon which the ties are to be laid. After the ties and rails have been properly laid and surfaced, the ballast must be filled up, as shown on standard plan, and also between the main tracks and sidings, where stone ballast is used. All stone ballast is to be of uniform size, and the stone used must be of an approved quality, broken uniformly, not larger than a cube that will pass through a 2½-inch ring. On embankments that are not well settled, the surface of the road-bed shall be brought up with cinder, gravel, or some other suitable material.

"*Cross ties.*—The ties are to be regularly placed upon the ballast. They must be properly and evenly placed, with ten inches between the edges of bearing surface at joints, with intermediate ties evenly spaced; and the ends on the outside on double track, and on the right hand side going north or west on single track, lined up parallel with the rails. The ties must not be notched under any circumstances; but, should they be twisted, they must be made true with the



CROSS SECTIONS OF SINGLE AND DOUBLE TRACK CONSTRUCTION—PENNSYLVANIA RAILROAD.

adze, that the rails may have an even bearing over the whole breadth of the tie.

"*Line and Surface.*—The track shall be laid in true line and surface; the rails are to be laid and spiked after the ties have been bedded in the ballast; and, on curves, the proper elevation must be given to the outer rail and carried uniformly around the curve. This elevation should be commenced from 50 to 300 ft. back of the point of curvature, depending on the degree of the curve and speed of trains, and increased uniformly to the latter point, where the full elevation is attained. The same method should be adopted in leaving the curve.

"*Joints.*—The joints of the rails shall be exactly midway between the joint ties, and the joint on one line of rail must be opposite the center of the rail on the other line of the same track. A Fahrenheit thermometer should be used when laying rails, and care taken to arrange the openings between rails in direct proportion to the following temperatures and distances: at a temperature of 0 deg., a distance of 5 16 in.; at 50 degs., 5-32 in.; and in extreme summer heat, of, say, 100 degs. and over, 1-16 in. must be left between the ends of the rails to allow for expansion. The splices must be properly put on with the full number of bolts, nuts, and nut-locks, and the nuts placed on inside of rails, except on rails of sixty pounds per yard and under, where they shall be placed on the outside, and screwed up tight. The rails must be spiked both on the inside and outside at each tie, on straight lines as well as on curves, and the spikes driven in such position as to keep the ties at right angles to the rails.

"*Switches.*—The switches and frogs should be kept well lined up and in good surface. Switch signals must be kept bright and in good order, and the distant signal and facing point lock used for all switches where trains run against the points, except on single-track branch roads.

"*Ditches.*—The cross section of ditches at the highest point must be of the width and depth as shown on the standard drawing, and graded parallel with the track, so as to pass water freely during heavy rains and thoroughly drain the ballast and roadbed. The line of the bottom of the ditch must be made parallel with the rails, and well and neatly defined, at the standard distance from the outside rail. All necessary cross drains must be put in at proper intervals. Earth taken from ditches or elsewhere must not be left at or near the ends of the ties, thrown up on the slopes of cuts, nor on the ballast, but must be deposited over the sides of embankments. Berm ditches shall be provided to protect the slopes of cuts, where necessary. The channels of streams for a considerable distance above the road should be examined, and brush, drift, and other obstructions removed. Ditches, culverts, and box drains should be cleared of all obstructions, and the outlets and inlets of the same kept open to allow a free flow of water at all times.

"*Road Crossings.*—The road crossing planks shall be securely spiked; the planking on inside of rails should be ¾ inch, and, on outside of rails should be ⅛ below the top of rail and 2½ inches from the gage line. The ends and inside edges of planks should be beveled off, as shown on standard plan."

The Division Superintendent.

IN an editorial commenting upon an article printed on another of its pages the *Engineering News* (Jan. 9) remarks upon the duties of a railway division superintendent as follows:

"It may be explained that the superintendent is in practical charge of the operating service of the railway, and on all roads of any importance there is one general superintendent, whose jurisdiction is over the entire line, and several division superintendents, each having jurisdiction over a certain division of the line. Two different systems are in use, with respect to the powers and duties of the division superintendent. In the first, he is given absolute control over his division, being the superior officer of the divisional force. In the second, he is merely a departmental head, ranking with the division master mechanic and the division engineer or road-master. In this latter case he is practically little more than a train-master or superintendent of train service, and has

little or no absolute authority, having to refer all matters of detail to the superior authority at headquarters, which authority has no personal knowledge of the local conditions or affairs. Under such conditions of divided authority there will almost of necessity be a great deal of formality and delay in regard to the every-day matters of the service, with consequent loss of time, money, and opportunities, and with probably more or less friction between the officers. This is not only the case in the dealings between the public and the railway, but also in the operating details. Thus, if the superintendent wants to send a work-train out to any part of his division, he has to apply to the motive-power department for an engine, and may not get an engine suitable for the service required. Similarly, if any part of the track requires prompt attention, a communication may have to be made to the general superintendent and then referred to the general manager, from whose office it is again referred to the chief engineer or head of the maintenance-of-way department, and thence through subordinate channels.

"By far the better practice, as is now very generally recognized, is to make the division superintendent the man in direct charge of the division, with power over all departments. Under such conditions he reports only to the general superintendent, but he is, of course, compelled to observe and abide by the general regulations and the standards of construction, etc., adopted by the company. On the Erie R. R., the division superintendent is in charge of the entire equipment and work of the division, including the maintenance of way, the providing and caring for the motive power and equipment, and the movement of passenger and freight traffic. He has under him a train-master, chief train dispatcher, road-master, and master mechanic, and he reports to the general superintendent and the superintendent of transportation. The higher officials are, therefore, not compelled to attend to matters of detail referred to them from various divisions, but all such matters are attended to directly by the local authority, who is conversant with all the affairs of his division. Records and accounts are, of course, kept by the general superintendent, and monthly statements are usually prepared, showing the traffic, expenditures, etc., of each division, so that a comparison may be made as to the efficiency and economy obtained on different divisions."

Electric Friction Brakes.

IN the *Street Railway Review* (March) Mr. A. K. Baglor recommends electric power braking for street cars and describes the mechanism thus:

"The commercial form into which this type of brake seems to have resolved itself consists of a circular iron plate made fast to the axle and turning with it in a plane parallel to that of the wheel, together with an electro-magnet, also in the form of a disk, which is held so that it cannot revolve. This magnet when energized is brought into close contact with the axle-disk, the resulting friction retarding the latter (and with it the car wheels), while at the same time the generator action going on in the motors tends to bring the armatures to rest. The magnetic friction method is to be preferred, as by its use all forces tending to propel the car are opposed directly and simultaneously, reducing all internal strains to a minimum, and bringing the vehicle to rest in the least possible time."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Railroad and Engineering Journals—See Introductory.

*4088. The Railroad Facilities of Suburban New York. Ill. Foster Crowell (Discussing the probable development of means of transit for the accommodation of districts surrounding New York within a thirty mile radius). Eng. Mag-March. 4200 w.

*4999. After the Great Railway Race. Charles Rous-Marten (A summary of details of some of the fast runs on English roads, with some reference to American records). Eng. Lond-Jan. 31. 4500 w.

4114. Oriental Railways. Clement F. Street

We supply copies of these articles. See introductory

(The writer visited Tunis, Egypt, and India, securing information for the Commission on World's Transportation of the Field Columbian Museum, and in this well illustrated description gives the results of his observations). Ry Rev–Feb. 8. Serial. 1st part. 3800 w.

4115. Home for Aged and Disabled Railroad Men. L. S. Coffin (An interesting letter to the editor from a R. R. President, showing how care may be taken of the helpless employees). Ry Rev–Feb. 8. 900 w.

4134. Electricity on the New York Elevated Railroads (A combination of third rail and storage battery to be tried). Elec Eng–Feb. 12. 1500 w.

4135. Electric Motors on the Brooklyn Bridge. Ill. (An account of the first official test of electricity as applied to the switching of the cars on the bridge). Elec Eng–Feb. 12. 1000 w.

*4147. Solid Floor Bridges for Railroads and Highways. Frank C. Osborn (Read before the Civ. Eng's Club of Cleveland. The author describes and illustrates all the principal forms of this construction that have been used; it is an interesting record of what has been done). Jour of Assn of Eng Soc–Dec. 11000 w.

†4153. The Cause of Train Detentions (Discussion. The causes are itemized and their relative frequency indicated in per cents). N. Y. R R Club–Dec. 19. 7000 w.

†4181. European Railroads: Mileage and Speed (Statistics showing that the average speed of express trains in Europe varies from 43.49 to 52.43 miles per hour. Reference is made to the late record-breaking runs). Con Rept–Jan. 700 w.

4184. Train Accidents in the United States in 1895 (Statistics covering a period of 22 years, classified according to causes; also figures for the year 1895, by months, with causes). R R Gaz–Feb. 14. 1100 w.

4185. The Stickney Track Indicator. Ill. (The instrument is attached to the bottom of the car and records automatically any sudden divergence from a straight line motion). R R Gaz–Feb. 14. 350 w.

4193. The Schuylkill Electric Railway (Illustrated description of railway at Pottsville, Pa) Elec Ry Gaz–Feb. 15. 1000 w.

4194. Mr. Sprague on Underground Rapid Transit. From the *N. Y. Evening Post* (An account of an interview with Mr. Frank J. Sprague). Elec Ry Gaz–Feb. 15. 1500 w.

*4197. Electric Traction in the Light of Recent Developments. Philip Dawson (Illustrated account of progress of electric traction in Europe). Elec Rev, Lond–Feb. 7. 1800 w.

4211. Snow Sheds of the Central Pacific R. R. (An illustrated description of the sheds, and the system employed to lessen damage by fire in the sheds, and consequent delay of traffic). Safety V–Feb. 900 w.

4212. Contributory Negligence (Claim for injuries caused by negligence of claimant and of fellow employé. A legal question). Ry Age–Feb. 15. 1500 w.

4221. Switching by Electricity at the Brooklyn Bridge Terminals. Ill. (The switching locomotives will be abandoned and one car of each train will be supplied with electric motors which will furnish driving power at the terminals, after the cable is dropped). Eng News–Feb. 13. 2300 w.

4222. The Relative Cost of Car Lighting by Pintsch Oil Gas and by Compressed City Gas (The tests show that for equal illumination compressed city gas costs 2¼ times as much as Pintsch gas). Eng News–Feb. 13. 350 w.

4224. Rail Sections and Wheels (Abstract of a paper read by Mr. Lodge at the meeting of the Engng. Assns. of the South, at Nashville. The writer discusses the relative wear of wheel and rail head and the influence of changing the quality of each). Eng News–Feb. 13. 1100 w.

*4237. Steel Sleepers. James Whitestone (A communication to the editor discussing the objections raised against steel railway ties, and comparing them with ties of wood). Eng, Lond–Feb. 7. 1600 w.

*4243. The Old Bodmin and Wadebridge Railway (An article of historic interest, giving views of a number of old cars). Ry Wld–Feb. 1400 w.

*4244. Westinghouse Enclosed Conduit System for Electric Traction (An illustrated description. The car takes the current from spaced contact pins in road-bed). Ry Wld–Feb. 1600 w.

*4256. Railway Charges in the Iron and Coal Industries (An excellent discussion showing the difference between English, continental and American railway rates. It is stated that English railways will have to earn nine times the amount earned by American railways in order to pay the same dividends). Ir & Coal Trs Rev–Jan. 31. 1500 w.

4264. Trucks for Lake Street Elevated Electric Motor Cars (Three designs are illustrated). Ry Rev–Feb. 15. 1500 w.

4270. Can Electricity Supplant the Steam Locomotive on Trunk Railways? William Baxter, Jr. (The object of the writer is to present the merits upon which electricity can base a claim of superiority in a fair and impartial manner. The first part is largely introductory). Elec Eng–Feb. 19. Serial. 1st part. 900 w.

4285. Hot Boxes (The article includes a number of useful practical hints). Age of St–Feb. 15. 1500 w.

*4289. Cedar Rapids and Marion City Railway. Ill. (Description of a well managed electric railway). St Ry Rev–Feb. 15. 1500 w.

4315. The Transportation Problem in New York City (Suggestions for increasing the facilities of the elevated roads, the Broadway cable road, and the Brooklyn bridge road). Sci Am–Feb. 22. 1800 w.

*4321. Specifications for Steel Rails of Heavy Sections Manufactured West of the Alleghenies. Robert W. Hunt (A revision of the author's specifications of 1888, with additional clauses

covering chemical composition and drop tests). Trans Am Inst of Min Engs–Feb. 2800 w.

4343. Central Water Supply Stations for Railways. Charles A. Hague (Illustrated description of supply well and stand-pipe supply of the Long Island (N. Y.) R. R). Eng News–Feb. 20. 1400 w.

4357. The Ninety and Nine J. N. Barr (A paper read before the Western Ry. Club. The writer shows the danger of neglecting the other departments while pursuing one that is inefficient, going into very interesting details). R R Gaz–Feb. 21. 2500 w.

*4361. Railway Accidents and Their Causes (Editorial discussion of particular cases). Trans–Feb. 14. 1800 w.

4378. Gross and Net Railroad Earnings in 1895 (Tabulated statement of the gross earnings and the net earnings of each road separately for each of the past three years). Bradstreet's–Feb. 22. 1000 w.

*4382. The Life of Iron Railway Bridges (An editorial discussion). Eng, Lond–Feb. 14. 2200 w.

4388. The Daily Car Situation. J. R. Cavanagh (Read at a meeting of the Indianapolis Div., Central Assn. of R. R. Officers. Suggestions as to forms governing the movements of cars). Ry Age–Feb. 22. 1000 w.

*4391. The Modern Locomotive. William Rowland (Paper read before the Liverpool Univ. College Engng. Soc. Calculations and considerations determining details in the design of locomotives). Prac Eng–Feb. 14. Serial. 1st part. 4300 w.

4404. European Practice in Overhead Trolley Construction (The European device is a sliding contact collector, and while it appears cumbersome, it possesses many excellent features). W Elec–Feb. 22. 1100 w.

*4414. The Profits of United States Railways (Editorial. Some interesting comments upon American railway securities. Compares the rates, traffic, etc., on American with that on English roads. The editor offers an explanation as to why the stocks are dealt in principally from a speculative point of view, in the London market). Engng–Feb. 14. 2500 w.

4426. State Control of Railroads vs. the Obligation of State Protection. President Blackstone (From the annual report of the president of the Alton R. R. The facts presented are of interest to all railroad managers). Ry Rev–Feb. 22. 2500 w.

4427. Air Brake Instruction Car—Michigan Central Railroad (Illustrated description). Ry Rev–Feb. 22. 600 w.

4433. Boston's Great Street Railway System. H. G. T. (Largest and best equipped service; —the "west end" and what it has done for Boston and her suburbs;—a brief outline of the system and its operation). Elec Rev–Feb. 26. 3400 w.

4449. The Westinghouse-Baldwin Electric Locomotive (Illustrated description). Elec Eng–Feb. 26. 500 w.

4450. Test of Rail Bonds (Results of some tests made by Mr. Robert Bunning, Master Mechanic of the Buffalo Railway Company. All the instruments were of the Weston type, and had just been recalibrated by the Weston Co). Elec Eng–Feb. 26. 400 w.

4482. The McMahon Dump Car. Ill. (A simple positive action, downward thrust device which forces open the drop doors, thus obviating the annoyance due to the chains usually employed, freezing fast to the coal and refusing to let the doors open). R R Gaz–Feb. 28. 1000 w.

4483 The Carriage of Bicycles (Editorial comment giving both sides of the question). R R Gaz–Feb. 28. 1300 w.

*4484. The Docteur System of Fireboxes with Firebrick Walls (From a paper by M. Docteur published in the *Revue Universelle des Mines*. The paper is well illustrated and the results of the experiments are given in detail. A saving of from 10 to 12 per cent. in fuel is claimed). Am Eng, Car Build & R R Jour–March. 2400 w.

†4524. The System of the Portland Railroad Company (The power station is fully described and illustrated by views and sections. It was intended as a model of its kind). St Ry Jour–March. 2500 w.

†4525. Some Recent Electric Railways in France (Illustrated description of two roads one between Roubaix and Tourcoing, the other between Raincy and Montfermeil). St Ry Jour–March. 1000 w.

†4526. Experience with the Electric Locomotive in Baltimore. Lee H. Parker (Considerable itemized data is given along with the considerations causing electricity to be adopted). St Ry Jour–March. 3200 w.

†4527. The Reasons Why Electric Motors Will be Used on the Brooklyn Bridge (The reasons why electric motors will displace the switching locomotives is fully discussed and views presented showing the bad effects of locomotive gases and the terminal arrangement). St Ry Jour–March. 1800 w.

†4528. Recent Work of the Boston West End Street Railway Company (The installation possesses many interesting features, among which are wrought steel fly-wheels, and the use of direct connected generators. Drawings of fly-wheel, stack and power-house arrangement accompany the article). St Ry Jour–March. 1400 w.

†4529. Why the T Rail Is not Satisfactory on Paved Streets in San Francisco. S. L. Foster (Excessive wear of the pavement adjacent to the rail was prevented by a flat rail laid on a redwood stringer, inside the rail, which then attracted the heavy traffic of drays). St Ry Jour–March. 900 w.

†4530. Power Brakes Upon Electric Cars. A. K. Baylor (The author shows how the revolving armature on the car axle may generate the power requisite for braking the car, after the driving current is shut off). St Ry Jour–March. 3000 w.

†4531. Rail Bonds (The best forms of bonds are described and illustrated). St Ry Jour–March. 2600 w.

4539. More European Street Railway Tick-

ets. Ill. Robert Grimshaw (Descriptive of tickets used in various places in Europe). Elec Ry Gaz–Feb. 29. Serial. 1st part. 1200 w.

*4555. Japanese Railways (A report upon the condition and extent of railway development containing interesting statistics. On March 31, 1894, there were 1938 miles of operating railways and 994 miles projected). Engng–Feb. 21. 1800 w.

*4561. The Midland Railway Company's Automatic Steam and Vacuum Brake (A very clear diagram drawing of the locomotive vacuum brake in detail, to which is appended a description). Eng, Lond–Feb. 21. 1500 w.

4638. The Baldwin-Westinghouse Electric Locomotive (A careful account, with illustrations, of the truck and general plan of the framing of the standard electric locomotive designed for, and built by the Baldwin-Westinghouse combination. This is apparently one of the most important steps yet taken towards the development of an electric locomotive for use on trains of considerable weight and speed). R R Gaz–March 6. 3000 w.

4639. The Question of Large Cars (An abstract of a report by a special committee of the New York Railroad Club on the important subject of an agreement for limiting the size of freight cars. The question is whether it is desirable or whether it is practicable to reduce the number of types of cars built and to keep the sizes down to specified maximum limits. The committee recommends keeping box cars down to 70,000 lbs. capacity and open cars to 80,000). R R Gaz–March 6. 2500 w.

4640. Testing the B. & O. Electric Locomotive (Extracts from a report by Mr. Lee H. Parker, engineer in charge of electric installation, on some of the performances of the heavy electric locomotive recently built for service in the Baltimore tunnel, with diagrams showing current and draw-bar pull). R R Gaz–March 6. 1500 w.

4641. Discipline on the Louisville and Nashville (An editorial giving considerable account of certain important modifications of the usual methods of discipline for railroad employees, as put in practice on this road). R R Gaz–March 6. 1500 w.

*4643. Roanoke Machine Shops. Ill. A. S. (The description includes some ideas which are of value to railroad men as being very good practice) Loc Engng–March. 1200 w.

*4644. Southern Railway Shops at Knoxville (An illustrated description). Loc Engng–March. 2700 w.

*4645. Central Railway of Brazil. Lewis Gleason (A lengthy description of the location, organization, operation, equipment, etc., of a very interesting road). Loc Engng–March. 5500 w.

*4646. Uniform Reports of Locomotive Performances—Authorized Standard Forms. George W. Cushing (Suggestions as to the form in which to make a locomotive report so that it can be compared intelligently with that of other locomotives). Loc Engng–March. 1200 w.

*4647. British Locomotive Designers are Slow (Criticism of points in design). Loc Engng–March. 800 w.

4651. The Sand Track. Robert Grimshaw (The discussion of methods which make a locomotive or car leaving the track as a safety measure, a safe thing to do. The article has some interesting data). Sci Am Sup–March 7. 1800 w.

4665. The Development of the Freight Car Door (An interesting communication, concluding with the features considered essential in a perfect car door). Ry Mas Mech–March. 2700 w.

4666. Standard Loading of Lumber and Timber. Pulaski Leeds (Rules for loading on freight cars lumber up to 100 ft. long. The directions are full and explicit). Ry Mas Mech–March. 500 w.

4667. Locomotive Grates for Anthracite Coal (Circular of inquiry issued by a committee of the Mas. Mech. Assn. which shows very plainly the points in practice which at present are demanding the attention of designers and operators of locomotives). Ry Mas Mech–March. 1800 w.

*4687. The New Caledonian Express-Engine Dunalastair. Charles Rous-Martin (A good example of a modern English engine. The center of boiler is 8-ft. above rails; the driving wheels are 6½-ft. diameter; weight of engine and tender is 87 tons; and a new feature is a very commodious cab, which is an innovation in England). Eng, Lond–Feb. 28. 2500 w.

*4693. Narrow-Gauge Light Railway; Caen to Dives and Luc sur-Mer (This 2-ft. gauge track in Normandy is equipped with 30 lb. rails, built at a cost of 2143l. per mile, exclusive of cost of land. The description includes six views from photographs). Engng–Feb. 28. 1300 w.

*4706. Intercommunication in Railway Trains. J. Pigg (Illustrated description of device intended for use on English railways). Elec Eng, Lond–Feb. 28. 2000 w.

*4709. Observations of English Railway Practice, with Some Account of the Fifth Session of the International Railway Congress. George B. Leighton (Read before the club, Jan. 8, 1896). Jour Assn of Engng Soc–Jan. 7000 w.

*4713. The Light Railways Bill (The bill is now presented to Parliament and will probably pass. The editor's remarks upon it are interesting as they reflect the sentiment and opinion of many). Trans–Feb. 28. 2000 w.

4718. Proposed Electric Railways in Colorado. J. W. Dickerson (Illustrated description of proposed road of the South Platte Railway and Power Co. intended to connect Denver with Cripple Creek. The current for the operation of the line is to be generated by water power at different points along the route). Elec Ry Gaz–March 7. 2000 w.

†4726. The Bursting of Air-Brake Hose. A. M. Waitt (Extracts from paper read before the Western Railway Club (Chicago). The result of careful examination of burst and worn-out hose, with the writer's suggestions for remedying troubles arising from the same, and much general information). Ind Rub Wld–March 10. 2700 w.

We supply copies of these articles. See introductory.

SCIENTIFIC MISCELLANY

How to Look up References in Physics.

FEW who have not had experience in looking up topical references have the slightest idea of the labor involved in such a research. All such as have not devised a system of their own, and many who have, will be thankful for the assistance afforded by Mr. Edward L. Nichols, whose remarks upon the subject, as related to the literature of physics, made in the Physics Seminary of Cornell University January 28, are presented in the form of an abstract in *The Sibley Journal of Engineering* for February.

The first pointer given is that by far the larger mass of valuable records in physical science is to be looked for in the present century. Back of this, extending through medieval times to the Greek school in Alexandria, are to be found older sources of knowledge, and the best guide to research in these is named as "Fischer's History of Physics (eight volumes), published in Göttingen." The eighth volume of this treatise contains an alphabetical list of authors, but no index of subjects. "Gehler's Dictionary," Leipzig, 1825 (new editions by Brandes, Gmelin, and others), and "Kopp's History of Chemistry," are named as good helps.

It is also easier to look up a subject where writers' names are known than from topics alone, for the simple reason that the classification of scientific papers under the author's name is a much less complicated matter than the arrangement of them by topics. The latter, indeed, is well-nigh impossible. The names of one or two writers on a topic the literature of which is to be looked up are almost always known, and these names serve as a key. The first step is to find where the papers of these known authors were published. For this purpose certain lists are to be consulted. In English we have the catalogue of scientific papers published by the Royal Society of London, 1867. This list goes back to the beginning of the present century, and is international in its scope. It covers the entire domain of science, and is, therefore, necessarily very voluminous. The original catalogue goes up to the year 1863, since which time two supplements have appeared; the first covers the whole alphabet to 1873, and the second, for the decade 1873-83, is now in preparation, and has already appeared up to the letter P.

This is the only complete author's list in the English language. In Germany, a similar book, dealing, however, chiefly with physics and allied subjects, and much more compact in form, is the "Biographical Dictionary" of Poggendorf, Leipsic, 1863,—a dictionary of scientific authors, containing a fairly complete list of titles under each name up to about 1860. This work gives also titles of the work of the very earliest physicists with brief biographical data. In 1877 the publishers of the great German journal of physics, the *Annals of Physics and Chemistry*, began the publication of the "Beiblatter," a journal in which the literature of physics of all countries is abstracted by a committee of eminent physicists under the direction of Prof. E. Weidemann. This periodical gives monthly summaries. At the end of each volume is a list of authors, and at the beginning a classified, but not alphabetical, list of papers. This is the best series for the period covered. A similar task has been recently undertaken by the Physical Society of London, with a view to forming in English a summary of the literature of physics. Systematic reviews of current electrical literature have likewise been regularly published by some of the technical journals. Such are the "Engineering Index" published in THE ENGINEERING MAGAZINE, and the synopses published by Carl Hering in *Electrical World*, and by Max Osterberg in *Electric Power*. The French *Journal de Physique* has published a series of abstracts, but they do not cover the ground exhaustively. "Index volumes of scientific periodicals afford the princi-

pal sources of information concerning the whereabouts of scientific papers. Especially serviceable are *The Philosophical Journal*, established 1798; *American Journal of Science*, established 1819; *Annales de Chimie et de Physique;* and *Annalen der Physik und der Chemie.*

"In 1888 the last-named journal published a register of the subjects contained in the entire Poggendorf series. This series covered the period from 1824 to 1877, during which Professor Poggendorf, the author of the 'Biographical Dictionary,' already mentioned, was editor of the *Annalen*. There is also an index of names from the *Annalen*, covering nearly the same period. The issues of this journal cover pretty nearly the entire period of modern scientific activity."

Of more modern journals the following are named: "*The Physical Review*, the *Astrophysical Journal*, and *Science*, in America; the *Journal de Physique*, in France; *Nature*, in England; the *Repertorium der Physik, Zeitschrift für Instrumentenkunde*, etc., in Germany; the *Nuovo Cimento*, etc., in Italy, to say nothing of the host of technical journals dealing with the various branches of engineering and with manufacturing interests."

Some of the peculiarities of these journals which are puzzling to those unaware of them, are named. Of these one of the journals that presents the most perplexing complications is *Poggendorf's Annalen*, which, since the death of Poggendorf, has been published as *Wiedemann's Annalen*. Much confusion exists in the numbering of the volumes. "Bookbinders are naturally thrown into confusion by these complications, and it is a matter of the greatest uncertainty as to which of the numbers will appear on the back. The set in the library of Cornell University, for example, is numbered by the binder with numbers which differ by sixty-eight from the number which one seeks, when counting from the beginning of the Poggendorf series." Similar complications arise in the cases of the *Annales de Chimie et de Physique*, the *Philosophical Magazine*, and the *American Journal of Science;* although the illustration just cited affords perhaps the most perplexing example. The transactions and proceedings of the Royal Society of London and the French Academy of Sciences are the most important aids to research. The *Philosophical Transactions* is a quarto publication running back to 1865, and the *Proceedings* are in octavo volumes, covering the period from the year 1800 to date. The French Academy publishes two sets, —the *Comptes Rendus*, from 1835 to date, and the *Memoires*, commenced in 1816.

Although the publications of the two societies named rank first in importance, there are numerous other scientific societies which are doing good work, and issuing valuable publications. An admirable classification and summary of these publications is *Wiedemann's Beiblatter.*

"Another useful periodical is the *Summary of Technical Literature*, founded in 1856, under the editorship of Schubarth in 1856, and giving titles as far back as 1824. The literature from 1856 on was worked up by Kerl, who was followed by Biedermann and later by Rieth, the present editor. The *Fortschritte der Electrotechnik* and the *Fortschritte der Physik* belong to the same class. The last named for many years lagged so much behind the times as to be of comparatively little value. It has, however, been recently taken in hand by the Physical Society of Berlin, and brought nearly up to date.

"Still another excellent source of information for the searcher in scientific bibliography is the volume of tables published by Landolt and Bernstein, Berlin, 1894. These tables afford not only the most trustworthy and valuable data concerning nearly all the constants of nature, but likewise references to the sources whence these data have been obtained. Under the headings given in this volume, which includes nearly everything which can be a subject of research in the domain of physics, we find an alphabetical list of the authors from which the lists have been taken. Nowhere else can one find in such compact form the list of the chief observers in any branch of physics."

This article will prove helpful to all technical readers.

New Form of Lighthouse Refractor.

THE latest advance in lighthouse appliances is described in *The Engineer* (Dec. 20). The following is an abstract of a description of the invention given in an article written by Mr. John A. Purves, B. Sc.

The essential and novel feature of this apparatus consists in the inversion of the facets of the lens elements, so that these, instead of projecting outwards, are made to project inwards, thus leaving the out-

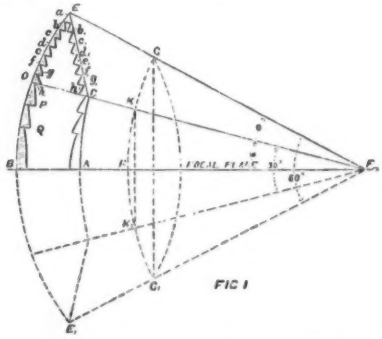


FIG 1

side face quite smooth. This arrangement with any form of prism but the equiangular—the invention of Mr. Charles A. Stevenson—would entail a loss at each arris, which above fifteen degrees from the focal plane would be very considerable. With the equiangular form of prism this loss is inappreciable up to fifteen degrees, and, as will be shown, is far more than compensated by the great gain produced in the increase of focal length, even when the inverse refractor is carried to a total height above and below the focal plane of thirty degrees, thus subtending a total vertical angle of sixty degrees. The new form of refractor, being approximately spherical, possesses all the advantages of the truly spherical refractor, while at the same time it has none of its disadvantages arising from abnormal divergences above 20 degrees, since the use of the equiangular prism produces the minimum amount of divergence possible over the whole refractor.

By using this form of refractor the same power of light can be obtained from a smaller apparatus, thus reducing the actual cost, enabling smaller lanterns to be used, and reducing the weight of the revolving apparatus,—an important consideration, as quick-flashing lights are so much employed.

The inverse lens has also the merit of utilizing to the fullest advantage the best part of the light,—namely, that immediately above and below the focal plane. Being practically spherical in form on the outside, the external gun-metal setting can be of the simplest, while internal ones might almost be dispensed with, as it is impossible for the rings of this apparatus to fall inward. The simplification of settings not only does away with loss of light, but reduces the weight of apparatus. Having briefly noted the points where the new and old forms of refractors differ, it now remains to be shown what the actual gain in power of the new inverse lens is. The plan adopted is that of a comparison of two hyper-radiant apparatuses, refractors only, the one which is compared with the new lens being of the most approved type,—namely, with spherical center and equiangular concentric rings of

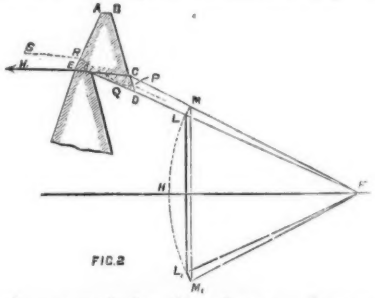


FIG 2

prisms completing the refractor. In comparing the new form of refractor, *B D E*, with the old composite form, such as *A C E*, in which *A C* is of spherical sections, the rest of the refractor, *C E*, being composed of equiangular prisms, it is necessary to take note of the following points: (1) both lenses subtend the same vertical angle,—Fig. 1, equal to sixty degrees; (2) in the case of the new lens, *B D E*, where the facets are turned inwards, we have a loss of light at each arris. This loss is most easily computed when we consider the area of the illuminated portion

of a sphere, of radius, *F H*, subtended by the cone whose angle is *G F G*, in comparison with the same surface of sphere minus the zones of partial darkness produced by the loss at the arrises.

To explain the loss at the arrises suffered in the new refractor we may refer to Fig. 2. In this figure, let *A B C D E* be one of a series of the inverted equiangular prisms; *F* the focus of the apparatus. Now, the focal ray, *F C*, after striking the glass at *C*, follows the course, *C E*, and then emerges finally in the horizontal direction, *E H*. Now, the next ray from the focus which will be truly parallelized is *F D*, which, falling upon *G*, so deals with the top point of the prism below *A B C D* as to cause it to emerge in the horizontal direction. It is now seen that the angle, *C F D*, represents so much loss, as any light within it is not truly parallelized. But, by bringing the face, *B C*, of the prism to *D*, this loss is reduced, for a ray falling upon such a point as *P* is refracted to *Q*, reflected from *Q* to *R*, and finally refracted again from *R* in a direction approaching the horizontal. We have, however, considered the loss sustained as being total, and we have calculated it as follows: the portion of the sphere whose radius is *F H*, and whose angle of cone in the apparatus considered is sixty degrees, will be reduced in the case of the new lens by zones of darkness upon it represented by *L M L M*.

A calculation shows that the total net gain of the new lens, over the old ones of same size and most approved form, is approximately 15.4 per cent.

Röntgen's Shadowgraphs.

THE following explanation of Röntgen's discovery, at present the most attractive subject of scientific study, is so clear and explicit that we do not hesitate to call it the best popular explanation which has yet appeared. It was received from a special correspondent of *American Journal of Photography*, and printed in the February number of that journal.

"For a considerable time past various physicists have been of the opinion that the oscillatory motion of vibration of light was not only transverse, but longitudinal as well. This theory was confined chiefly to such light rays as were absolutely invisible to the eye, and entering upon the ultra-violet. In the daily papers communications have appeared at various times regarding these vibrations, among the latest being the highly-colored accounts of the experiments by the Wurzburg Professor Röntgen. It is here stated that Professor Röntgen succeeded in obtaining photographs, by aid of these invisible rays, without the use of any photographic apparatus. This statement, impossible as it may appear at the first glance, may be explained by the following statement of facts.

"If an induction current is passed through a Geissler tube filled with rarefied air, there appears upon the negative electrode a thin seam of light surrounded by a relatively dark, bluish glow of light. The surroundings of the positive electrode, on the contrary, and the larger part of the enclosed space, are filled with strata of bright, red-yellow light. This phenomenon changes perceptibly when the rarefaction of the air within the Geissler tube is increased. When a certain degree of rarefication of the air is reached, the blue glow-light expands, and, under certain conditions, fills the whole interior of the tube. When this is the case, the glow-light causes a fluorescence wherever it strikes the glass.

"This phenomenon was studied and published by Hittorf so far back as 1889. Subsequently other scientists beside Hittorf and Crookes occupied themselves with the study of this phenomenon. Prominent among the latter were such authorities as Reitlinger, E. Goldstein, Gintl, Pubeg, Voller, Zoch; and the conclusion was reached that these cathodic rays were endowed with a series of peculiar properties. The most curious of these qualities is that the cathodic rays spread themselves (grad–linig), and not as those of the induction current, which turn corners and follow all the turnings and twistings of the tube. This peculiarity of the cathodic rays was not discovered by Röntgen, but has been known in scientific

circles since the publication of Hittorf and Crookes. The former, as well as the latter, gave very explicit instructions for experiments which would show the chief properties of the cathodic rays. Probably the best account is to be found in the well-known text-book of Muller-Pouillet.

"Even the peculiarity of the cathodic rays, to show a unique shadow-structure, and which now forms the leading wonder in Röntgen's experiments, has long been known, and attention had been called to it. Now Professor Röntgen has substantiated the fact that the cathodic rays were not undulatory, but extended in straight lines, and were able to penetrate almost all solid bodies, metallic, of course, to a less degree than wood, etc. Röntgen covered with a roll of thick black card-board a Geissler tube in which cathodic rays could be produced. Notwithstanding that no rays of light whatever could escape, he noticed in the completely-darkened room that a screen with luminous paint, which was on line with the covered tube, became luminous or phosphorescent. The action of the light was noticeable on the paint up to a distance of two meters from the apparatus. When any solid objects were placed between the screen and the covered tube, it was noticed that almost all substances were penetrated more or less by the cathodic rays. A pine board an inch thick had no more effect in obstructing the rays which Röntgen temporarily designates as X rays than several thicknesses of hard rubber plates. Metals, on the contrary, even in thin sheets, exercised a more or less weakening effect upon the rays. All of the super-imposed solids threw a more or less dense shadow or penumbra upon the luminous screen.

"As an example, when the hand was held between the tube and luminous screen, a shadow is created in which the bones of the hand are distinguishable by a much deeper shadow than that formed by the more transparent substances. One great advantage, thanks to modern photographic methods, is that these shadow pictures can be made permanent by simply substituting for the luminous screen a sensitive plate, film or paper, which, after exposure, can then be developed and fixed in the usual manner: these results, however, are by no means a photograph in the accepted sense, but merely a shadowgraph or silhouette, which, under the best conditions, may consist of a penumbral shadow, showing different degrees of density."

Scientific Kite-Flying.

THIS title to a most interesting article by Mr. Cleveland Moffett in *McClure's Magazine* for March might also have been made to read "Utilitarian Kite-Flying," since its perusal will convince any one that kite-flying can minister to numerous and useful ends. People have been so wont to regard kites as mere toys, and kite-flying as a mere amusement, that, although the great Franklin made it serve a useful scientific purpose in his famous experiment with kite and key in drawing electricity from the clouds, few have really ever seen the real possibilities of kites as factors in human progress.

An article by Professor J. Woodbridge Davis, page 213, vol. 7, of *The Engineering Magazine*, entitled "The Kite as a Life-Saver at Sea," describes a mode of rendering kites dirigible and of great strength in flight, invented by the author of that interesting paper.

Some of the experiments therein described are, indeed, remarkable. Mr. Moffett's paper sets forth other uses to which kites can be put. First, he gives plain deductions for making tailless kites, these being preferable for most of the purposes named, and also gives directions for manipulating kites, which show that perfection in the art of making flying kites is to be reached only by patient aspirants. But, when sufficient skill is attained, the kite may become an important appliance in the study of atmospheric phenomena; in fact, by its aid important contributions to meteorological science have been made already.

Another useful purpose is the taking of bird's-eye photographs. Several examples of views taken from high altitudes by means of kites, by Mr. Eddy of Bayonne, N.J. (yclept by Mr. Moffett the "king of kite-flyers"), illustrate the article under re-

view, and demonstrate the practicability of the kite as an aid to photography. These views show that in military engineering, and perhaps in other branches of engineering, the kite can now take rank among scientific appliances for surveying. The apparatus employed for taking photographs from high altitudes is described as follows:

"A wooden frame capable of holding the camera has attached to it a long stick or boom, by means of which the camera is made to point in any desired direction or at angle. This is arranged before sending up the apparatus, the boom being properly placed and held in position by means of guy cords from the main kite-line. A separate line hanging from the spring of the camera shutter, with which is also connected a hollow ball of polished metal supported in such a way that it will drop from its position, five or six feet through the air, when the camera cord is pulled. The purpose of this ball is to allow the operator on the ground to be sure that the camera has responded to his pull, and that the desired photograph has been taken. He is assured of this, having given the pull, on seeing the flash made by the polished ball in its fall.

"All this being arranged, it is only necessary to send the camera up to any desired altitude and pull the camera cord, in order to get photographs of wide-stretching landscapes, extensive cities, like New York, and panoramas of every description. Such photographs could not but be of the greatest value to geologists, mountain-climbers, surveyors, and explorers. And they must possess particular interest for students of geography and for map-makers."

The application to military *reconnoissance* is obvious, and the greater convenience of the kite, as compared with captive balloons hitherto employed for this purpose, is also recognized.

"Mr. Eddy regards it as perfectly possible to send up a tandem of kites from the deck of a man-of-war, with a circular camera, such as has already been devised, attached to the main line, and an apparatus for snapping all the shutters simultaneously; and photograph, not only the whole horizon as seen from the deck of a vessel, but, because of the greater elevation, many miles beyond. A battle-ship provided with this photographic device would enjoy as great advantage as if it were able at will to stretch out its mainmast into a tower of observation a mile high.

"It is true that some of the lenses in the circular camera—the ones facing the sun—might give imperfect pictures, but, in whatever position the sun might be, at least one hundred and eighty degrees of the horizon would be clearly photographed. And, by taking such observations in the early morning, and again in the middle of the afternoon, it would be possible to cover the whole circuit, and thus be aware of the approach of an enemy's ships long before they would have been visible to a telescope used on the deck. In such a circular camera each lens would be numbered, and the position of each would be accurately determined with regard to the points of the compass by the use of guy-cords stretching from the main line to the framework of the apparatus. Thus, on looking at the number of a lens, the photographer would immediately know the vessel photographed."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Scientific and Engineering Journals—See Introductory.

*4089. Prof. Röntgen's Discovery in Photography. Ill. Michael I. Pupin (Its scientific character and possible application throughout all branches of science, as indicated by Mr. Pupin's re-performance at Columbia College laboratory of Prof. Röntgen's extended experiments). Eng Mag-March. 1896. 2000 w.

*4120. The New "Rays." Sydney F. Walker (A letter to the editor calling attention to the fact that the writer contributed, about three years ago, his views relating to electricity, magnetism, etc., which are confirmed by Röntgen's experiments; with explanation of his reasons for his views). Elec Eng, Lond-Jan. 31. 1500 w.

*4121. On the Rays of Lenard and Röntgen. Oliver Lodge (A review of the events and experiments in this field, with a consideration of the

We supply copies of these articles. See introductory.

facts established and views entertained). Elect'n –Jan. 31. 4000 w.

*4122. Prof. Röntgen's Epoch-Making Discovery (The closing remarks of a paper in the *Zeitschrift für Elektrotechnik*, by Prof. Boltzmann, supporting the idea that the explanation of the rays lies in the longitudinal vibrations in the ether. Also editorial). Elect'n–Jan. 31. 1700 w.

4128. Roentgen's Shadowgraphs. R. H. Read (Describes a test by an English experimenter). Elec Rev–Feb. 12. 500 w.

4129. "X Ray" Photography. H. G. T. (A chat with Prof. A. E. Dolbear on this subject. His experiment in 1892, and a few points wherein he differs with Prof. Roentgen). Elec Rev–Feb. 12. 1300 w.

4132. Cathodographic Experiments. Elihu Thomson (Illustrated suggestions for the purpose of assisting experimentation in this field). Elec Eng–Feb. 12. 1200 w.

4133. Mr. Edison's Experiments with X-Rays (Illustrated account of work done by Mr. Edison in this field). Elec Eng–Feb. 12. 1300 w.

4136. Röntgen Rays (A brief summary of the experiments and investigations in this country during the week ending Feb. 15, with editorial). Elec Wld–Feb. 15. 2300 w.

4140. A Few Remarks on Experiments with Roentgen Rays. M. I. Pupin, with editorial (Illustrated account of further experiments by the writer, with observations of general interest). Elec–Feb. 12. 2300 w.

4173. The Gobelins Tapestry Manufacture. Robert Grimshaw (Interesting history of a great art industry. Illustrations of noted works by the Gobelins). Sci Am Sup–Feb. 15. 2800 w.

4176. Roentgen or X-Ray Photography (Illustrated description of experiments of Prof. Wright, at Yale). Sci Am–Feb. 15. 1800 w.

4178. William Crookes. Ill. (Sketch of his life and his remarkable discoveries, and contributions to scientific literature). Sci Am–Feb. 15. 900 w.

4191. Photographic Experiments in Chicago with Röntgen Rays. Frank L. Perry (Illustrated description of experiments made). W Elec–Feb. 15. 1600 w.

4192. Experiments on the X-Rays (An account by Edwin B. Frost of Experiments made at the Dartmouth physical laboratory. Also an account by Arthur W. Goodspeed of experiments made in the physical laboratory of the University of Pennsylvania). Science–Feb. 14. 1000 w.

*4196. The X-Rays (Editorial review of investigations made to determine the nature of these rays). Elec Rev, Lond–Feb. 7. 1200 w.

*4200. Röntgen's Radiations (Editorial on the progress made during the last two weeks, in ascertaining the properties of these new radiations). Elec Eng, Lond–Feb. 7. 700 w.

*4238. The Chimney Disaster at Burnley. Ill. (The conditions precedent and the immediate causes of the collapse of this great chimney are described. Incidentally some reference is made to other similar catastrophes, fortunately of rare occurrence. The evidence before the coroner's jury is the basis of the paper). Eng, Lond–Feb. 7. 4000 w.

†4239. The Utilization of Waste Steam. From *The Paper Makers' Circular* (Treats of the utilization of waste steam in manufacturing, more particularly in paper-making). Ind & East Eng–Jan. 18. 1400 w.

†4240. Humidifiers and Ventilators (Illustrated description of a new apparatus for regulating the hygrometric condition of the atmosphere of manufacturing establishments, more particularly those producing textile fabrics, whereby much more uniform results are attainable than heretofore). Ind & East Eng–Jan. 18. 800 w.

*4266. On the Present Hypotheses Concerning the Nature of Röntgen's Rays. Oliver Lodge (An examination of hypotheses advanced thus far in the study of these rays, with the conclusion that no satisfactory proof has yet been reached). Elect'n–Feb. 7. 3800 w.

4271. Photographing Hidden Objects by the Arc Light. J. Hart Robertson (Description of an experiment made by the writer). Elec Eng–Feb. 19. 700 w.

4272. Cathodographs by the Discharge of Leyden Jars and Other Disruptive Discharges of Static Electricity. Ill. William James Morton (An experiment which demonstrates that cathodography can be accomplished simply by the aid of charged Leyden jars alone). Elec Eng–Feb. 19. 800 w.

4273. On Radiant Matter. William Crookes (A lecture delivered before the British Assn. for the Advancement of Science, Aug. 22, 1879, and of special interest now, because of the recent discoveries). Elec Eng–Feb. 19. 1800 w.

4274. The Week's Progress in Shadow Photography (A review of work by various scientists during the past week). Elec Eng–Feb. 19. 700 w.

*4290. Catenary Problems. G. M. Minchin (Graphic methods for solving problems in catenary curves involving, by the mathematical method, the use of transcendental equations). Engng–Feb. 7. Serial. 1st part. 2500 w.

4299. Incandescent Gas Lighting for Photographers (Extract from paper read before the Croydon Camera Club by Mr. John A. Hodges, reprinted from the *Gas Engineers' Mag.* Discusses advantages of the incandescent gas light to photographers, and methods of applying it). Pro Age–Feb. 15. 1900 w.

4310. Röntgen Rays (A review of work done by different scientists during the past week or two, with editorial). Elec Wld–Feb. 22. 2000 w.

4312. Röntgen Rays With Statical Machines. Ill. M. I. Pupin (Experiments made with the object of ascertaining whether satisfactory results could be obtained by the employment of the Holtz machine. The results were quite satisfactory and some interesting facts relating to time of exposure, effect, etc., were determined). Elec–Feb. 19. 800 w.

4313. Communications From William J.

Morton and M. I. Pupin (A controversy, with editorial). Elec–Feb. 19. 2800 w.

4316. The Manufacture of Tacks (Sketchy, illustrated description of machines and processes). Sci Am–Feb. 22. 700 w.

4320. Chemistry as a General Education. Peter T. Austen (A paper read before the Students' Chem. Soc. of the Polytechnic Inst. on the usefulness of the profession of chemistry in the arts, and general effects of the study as an educational pursuit). Sci Am Sup–Feb. 22. 5200 w.

*4352. Professor Röntgen's Miraculous Photographs Explained. Julius F. Sachse (One of the clearest and most explicit popular explanations of Professor Röntgen's discovery that has yet appeared). Am Jour of Photo–Feb. 1000 w.

*4370. Technical Institutes. Sidney H. Wells (A paper read before the Arch. Assn., England. General remarks. The requirements are divided for convenience in treatment into (1) educational, (2) administrative, (3) recreative and social, (4) general). Arch, Lond–Feb. 14. Serial. 1st part. 6000 w.

4403. The New Photography. W. M. Stine (A review of the ideas advanced regarding this new discovery, with some views of the writer). W Elec–Feb. 22. 1900 w.

*4410. New Properties of the Cathode Rays. Jean Perrin (Translated from *Comptes Rendus*. An account of experiments made by the writer for the purpose of investigation). Elect'n–Feb. 14. 900 w.

*4430. How to Look Up References in Physics. Edward L. Nichols (Abstract of some remarks made in the Physics Seminary of Cornell University. An admirable guide to those who wish to explore the literature of physics with reference to any particular subject or topic. Within what dates, how to look, where to look, and what to look for are very clearly presented, thus outlining a systematic investigation which in its nature will be thorough instead of discursive). Sib Jour of Engng.–Feb. 2000 w.

4431. Röntgen Rays (A review, with abstracts of articles written by men of eminence in scientific investigations, which have recently appeared in various periodicals. Illustrations of some of the experiments are given). Elec Wld–Feb. 29. 2400 w.

4452. Photography with Invisible Radiations (Editorial on the importance of a correct knowledge of the new phenomena, and the value of investigations). Elec–Feb. 26. 1000 w.

4463. Scientific Kite-Flying. Cleveland Moffett (An interesting account of the work of Mr. Eddy, of Bayonne, N. J., treating of how to make a scientific kite; how to send up a kite; runaway tandems; the meteorological use of kites; the highest flight ever made by a kite; drawing down electricity by a kite string; the use of kites in photography, the possible use of kites in war, etc. Also reproductions of photographs taken from a kite and other pictures). McClure's Mag–March. 8000 w.

*4470. Fruit Culture in the Himalayas (It appears that a great variety of fruits flourish in this region; among those named are apples, pears, peaches, plums, and cherries. The conclusion is that Himalayan fruit culture can be made a lucrative business, with some outlay of capital and with scientific culture). Bd of Tr Jour–Feb. 900 w.

4491. Experiments with the X-Rays at Armour Institute Laboratories. W. M. Stine (A summary of the experiments, with results). W Elec–Feb. 29. 2800 w.

4494.—$1. New Academic Degrees at Paris. C. W. A. Veditz (Discusses recent changes and proposals for reorganization in the French universities, of interest to American students contemplating foreign study). An Am Acad–March. 1700 w.

*4499. The Nicaragua Canal an Impracticable Scheme. Joseph Nimmo, Jr. (The author declares from results of his own compilation that the amount of tonnage that has been estimated would pass through an American interoceanic ship-canal has been greatly exaggerated. Upon this and other considerations he concludes that the scheme of a Nicaragua canal is impracticable, and he charges that from the beginning, its promoters and advocates have studiously avoided anything like a thorough discussion of the economic and commercial conditions which determine the question of practicability). Forum–March. 6000 w.

†4502. Jamaica as a Field for Investment. Henry A. Blake (An interesting description of the natural resources and commercial opportunities of this island, in which the climate is healthy, the soil fertile, and in which it is predicted the unthrifty methods that have hitherto prevailed are soon to be replaced by systematic cultivation, and increased facilities for transit). N Am Rev–March. 2000 w.

*4505. The Production of Iron. Ill. (A description of ancient methods, including its early history in England). Mach, Lond–Feb. 15. 1700 w.

†4511. Steppes, Deserts, and Alkali Lands. E. W. Hilgard (An explanation is herein attempted, of the singular fact that the countries which have harbored most of the ancient civilizations are regions of deficient rainfall and compulsory irrigation; and an examination of the effect of deficient rainfall upon the character of soils in arid regions). Pop Sci M–March. 4800 w.

†4537. Sumatra Tobacco (Particulars of the development of Sumatra tobacco planting obtained from the Consul-general of the Netherlands). Cons Rept–March. 1700 w.

*4540. Experiments with Soaring Machines. Ill. Percy S. Pilcher (A letter objecting to a statement made regarding his success, and giving some account of his experiments). Nature–Feb. 20. 1000 w.

*4541. The Röntgen Rays (A summary of the more important results obtained since the publication of Prof. Röntgen's paper). Nature–Feb. 20. 4600 w.

*4557. Professor Dewar's Apparatus for Liquefying Air and Oxygen (Illustrated description of an apparatus whereby a temperature of —180° C. is obtained in from 25 to 30 minutes). Engng–Feb. 21. 200 w.

†4580. A Ferruginized Tree. Oscar C. S. Carter (Description of a tree found in Montgomery Co., Pa., that has been ferruginized or pseudomorphosed into iron ore. The geological and mineralogical environment shows a curious relation to this rare phenomenon). Jour Fr Inst–March. 800 w.

*4585. On the Production of Electric Phenomena by Means of Roentgen's Rays. Auguste Righi (From the Proceedings of the R. Accademia delle Scienze dell' Instituto di Bologna). Elect'n–Feb. 21. 1800 w.

*4587. Röntgen Rays and Their Source. Ill. T. H. Muras (A few particulars of some experiments with ordinary apparatus). Elec Rev, Lond–Feb. 21. 1300 w.

*4588. On the Rays of Röntgen. E. Salvioni (A communication made to the Medico-Chirurgical Academy of Perugia. Results of some studies undertaken by the writer). Elec Rev, Lond–Feb. 21. 800 w.

4592. The Importance of Water in Plant Production. Thomas F. Hunt (The writer considers the water supply the most important factor in farming and gardening operations). Brick–March. 6000 w.

4595. Farm Drainage. John Cownie (Some consideration of the importance of drainage and irrigation, and recommending the securing of legislation to aid the farmer in draining his land). Brick–March. 3300 w.

4596. Drainage Laws. Joseph A. Williams (The law of drainage in the state of Iowa is discussed). Brick–March. 4000 w.

4597. Measurements of High Temperatures for Clay-Workers. Edward Orton, Jr. (The known ways of measuring heat are classified and briefly considered, and the Seger cone and its advantages are presented). Brick–March. 4400 w.

4599. Light Rays Which, in Their Penetrating Power, Resemble Roentgen's X-Rays. N. D. C. Hodges (The purpose of this note is to call attention to the properties in common of certain radiations which, while somewhat unusual in character, have been classed hitherto as light rays not essentially peculiar in their method of propagation, with those radiations which are now known as Röntgen's X-rays). Elec Eng–March 4. 500 w.

*4608. Experiments Upon the Cathode Rays and Their Effects. Arthur W. Wright (Illustrated description of experiments performed at Sloane Physical Laboratory, of Yale University, and suggestions derived from a consideration of the circumstances under which the different shadowgraphs were produced). Am Jour of Sci–March. 4200 w.

†4609. Triangulation by Means of the Cathode Photography. John Trowbridge (Describes an attempt to apply the principles of triangulation to indicate more exactly the position of concealed bodies whose presence is revealed by Röntgen's method). Am Jour of Sci–March. 800 w.

†4610. Notes of Observations on the Röntgen Rays. Henry A. Rowland, N. R. Carmichael, and L. J. Briggs (These observers assert that in a tube with aluminum poles they have determined that the main source of the rays is a minute point on the anode nearest the cathode, and that the whole of the anode gives out a few rays. In this tube the cathode gave out no rays). Am Jour of Sci–March. 600 w.

4627. Röntgen Radiographs. Ill. (Engravings of radiographs made by Mr. Herbert B. Shallenberger, are explained and the experiments described). Elec Wld–March 7. 800 w.

4631. The Röntgen Rays. D W. Hering (General remarks). Elec Wld–March 7. 1600 w.

4653. Apparatus for Copying and Enlarging by Photography. A. P. Wire (Comprehensive description and explanation of processes and apparatus required, with numerous diagrams). Sci Am Sup–March 7. 2500 w.

4668. Application of the X-Rays to Surgery. Henry W. Cattell (A brief consideration of what has already been accomplished in this direction, with an enumeration of a few achievements we may expect). Science–March 6. 1000 w.

4671. Further Experiments with Röntgen Rays. W. M. Stine (Descriptive). W Elec–March 7. 1200 w.

4672. Application of X-Rays for Exhibiting Invisible Objects in Motion. Edward P. Thompson (Experiments described). W Elec–March 7. 700 w.

4673. Röntgen Photography. H. S. Carhart (Observations on experiments made by writer). W Elec–March 7. 400 w.

4674. Sciagraphs and Electrographs. W. M. Stine (Illustrations and descriptions of supposed sciagraphs, investigated with the view of discriminating between true and spurious sciagraphs). W. Elec–March 7. 1500 w.

*4684. The Palette of the Potter. William Burton (Processes, colors, and methods employed in pottery painting, and the effect of firing upon colors so used. Contains valuable information upon the subject. Discussion). Jour Soc of Arts–Feb. 28. 13000 w.

*4712. Photography of Invisible Objects. Ill. J. J. Stewart (A short statement of the facts discovered and the methods of experimenting employed by Prof. Röntgen). Knowledge–March 2. 1500 w.

*4722. The Röntgen Rays. J. J. Thomson (An account of investigations made to determine the nature of these rays). Nature–Feb. 27. 1500 w.

†4727. The Use of Gutta-Percha in the United States. John M. Armstrong (The history of gutta-percha, its discovery, uses, etc., and its importance. Comparison is made with India-rubber, showing the radical difference between the two gums). Ind Rub Wld–March 10. 2500 w.

†4728. A Traveling Man on Brands. F. C. Anderson (Dealing with brands on rubber goods, but equally applicable to other products). Ind Rub Wld–March 10. 500 w.

IMPROVED MACHINERY

NEW PROCESSES. NEW APPLIANCES.

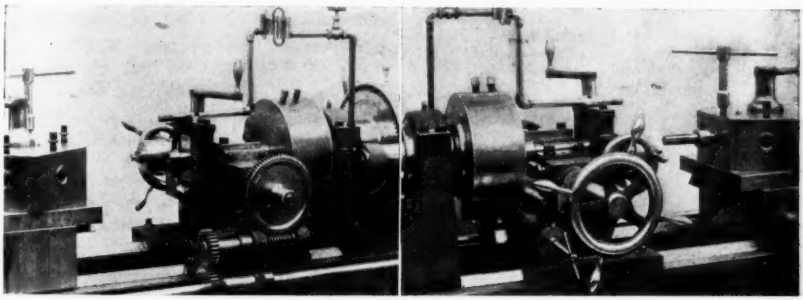
The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

A New Bicycle Hub and Screw Machine.

THIS new bicycle hub and screw machine is readily and quickly convertible from the one function to the other, and is capable of turning hubs, cups, cones, axles, screws, studs, etc., with nearly equal facility. The machine, of which front and rear views are shown, has the Parkhurst wire feed complete, and friction clutch back gears. The hub-turning rest and the steady rest for the bar and cutting-off rest form a single attachment, with a large bearing on the bed and gibbed directly to it. The cuts show a wheel hub in the steady rest, and another in process of

REAR VIEW.

FRONT VIEW.



BICYCLE HUB AND SCREW MACHINE.

turning. The roughing tool is at the back. The finishing tool is in front, and serrated to break the cut. Both tools are sharpened by grinding on the end. The roughing tool cuts in advance of the finishing tool until nearing the size, when, by an increased feed, the front tool is advanced to do the finishing, an automatic stop permitting an adjustment to .001 inch. The turret may be either hexagonal or round, as desired. The index plate is tool steel, hardened. The locking key, also of hardened tool-steel, has a taper gib wedge to take up the wear. The feed will carry a 3-inch drill into solid, hammered, crucible spindle steel. A double cut-off screw machine rest is furnished with the machine.

The principal dimensions are as follows: Swing over bed, 22 in.; length of bed, 7 ft.; weight, 4,500 lbs.; hole in spindle, 3¼ in.; takes through wire feed, $2\frac{7}{16}$ in.; diameters of spindle cone, $7\frac{5}{16}$ to 13¾ in.; width of cone, 4½ in. This excellent machine tool is manufactured by the Lodge & Shipley Machine Tool Co., of Cincinnati, Ohio.

A Remarkable Record.

WHEN the history of steam engineering in the United States shall be written, the work of the Edward P. Allis Company, of Milwaukee, Wisconsin, will be cited as that of one of the great firms whose efforts at refinement in the art have most contributed to sound improvement and permanent advance. In theory and practice this firm has steadily maintained its position in the front rank of American engineering, and has been able to secure well-earned triumphs that reflect honor not only upon a particular business and engineering reputation, but upon the nation. The reputation of the house has, however, become not merely national, but world-wide, and the name of this company ranks with those of the great European engineering establishments everywhere known and universally respected as chief factors in the advance of civilization. One of the latest triumphs secured by the company is

the record of remarkable performance of an Allis Cross Compound Engine, 22" × 40" × 48," supplied with steam from two 84" Reynolds Vertical Boilers, at the Stevens Linen Works, Webster, Mass. This is not a mere short-run record, but a record of three years' service. The boilers were used exclusively for the engine and the figures for coal consumption include all-night banking. The engine, has been regularly indicated morning and afternoon for daily report, and here is the remarkable record.

	1893.	1894.	1895.
Average I. H. P. for year	381	393	396
H. P. hours for year	1,042,221	893,792	1,076,134
Engine Coal for year	1,831,700	1,493,243	1,775,720
Average coal per I. H. P. per hour for one year	1.76	1.67	1.65

If any compound engine in existence can beat this record for three years service, we have not heard of it. One imagines what would be the wonder of Boulton & Watt, could they revisit earth, and witness such a performance.

A Novel Pipe Wrench.

THE accompanying cut illustrates the STAR PIPE WRENCH manufactured by The Van Auken Steam Specialty Co., 203 South Canal street, Chicago, of which company Mr. C. P. Monash is manager. This wrench is claimed to be the simplest pipe wrench that has ever been placed upon the market, and superior convenience and durability are also claimed for it. It has only three pieces, made without a spring, and it is interchangeable in all its parts. The simple improvement of the "slant" on the heel makes "sticking" on the pipe impossible, and also enables it to release its hold instantly. Conversely the "slant," together with the toothed jaw, enables it to grip the pipe firmly without any lost motion or slip. It would seem that its use cannot mash the pipe. The movable jaw and nut are made with an oval top thread, which the manufacturers guarantee never to strip or burr. The construction of the improved heel enables the wrench to ratchet a nut or coupling without marring or rounding corners. It is further claimed that this wrench may also be used to turn up solid stud bolts, for which work the strongest possible construction is needed in a wrench.

Old Time Relics.

CONSIDERABLE interest has been expressed in building circles in an exhibition of several pieces of old roofing tin now in the possession of Messrs. N. & G. Taylor Co., Tinplate Manufacturers, of Philadelphia. These samples are justly regarded as practical illustrations of the efficiency of the "Taylor Old Style" brand of extra heavy coated roofing plates, under the severest tests of both time and wear.

One of them is from the roof of the old Bloodgood's Hotel on Dock Street, Philadelphia, which was demolished some years ago to make room for the Pennsylvania Railroad Company's Freight Station. Notwithstanding the fact that this roof had been in active wear for forty-four (44) years, the tin was found to be bright and perfect, and in fact, just as good as when first put on.

The second relic is a piece taken from the roof of a residence at Edgewater Park, N. J., put on in 1855, in active service for thirty-five (35) years, and never painted but once. The piece is even now equal in every respect to the best plates, bright and new as they are now in stock and for sale on the floor of the company's ware-rooms.

The third sample was taken from the roof of a building at Independence, Mo., which had been in active service over thirty years, and had never been painted.

Of course, the N. & G. Taylor Co. were delighted to be able to secure these tangible evidences of the lasting qualities of their favorite brand of roofing tin, and it is but natural that they should attach the highest possible importance to them as souvenirs of the early business success and history of the firm.

In 1830 roofing, or Terne Plates, were first made in Philadelphia, and were then handled by

this concern and at present in Philadelphia, many tin roofs made from the Taylor Old, Style" brand are said to be in as good a state of preservation as when put on over sixty-five years ago.

It is claimed that the great wear secured in this brand of roofing plates is owing to each sheet being dipped by hand in open pots of heated metal, no rolls being used to squeeze off the metal coating; instead of this the sheets are placed upon racks to cool, every particle of coating being thus retained. Previous to the dipping the black plates undergo what is known as the "palm oil process"; the plates in this process are treated with pure palm oil, and do not come in contact with any acid flux.

The works of the company are located on Tasker street, between Swanson and Meadow, where the public is invited to see how roofing tin is made.

Steeple Compound Marine Engines.

THERE are numerous small steam craft *doing business* on salt water in which one of the "pretty" but lightly built compound yacht engines is somewhat out of place and a useless extravagance. We refer in particular to the all-around, steady going, hard-working, and money-producing boats that require substantial, easily-operated condensing machinery; the economical kind that can be relied upon at all times with absolute certainty; boats for general utility and continuous service, in which cargo space, fuel space, and even passenger room is of especial value. For such craft in particular is the "Steeple" Compound Engine, described and illustrated herewith, specially designed. These engines are built by the Marine Iron Works, Chicago, Ill.

The outline sketch (reduced from scale drawing) shows for itself to the engineer and requires no particular explanation further than to say that *all* proportions and bearings correspond with the crank and crank-pin dimensions given in the table.

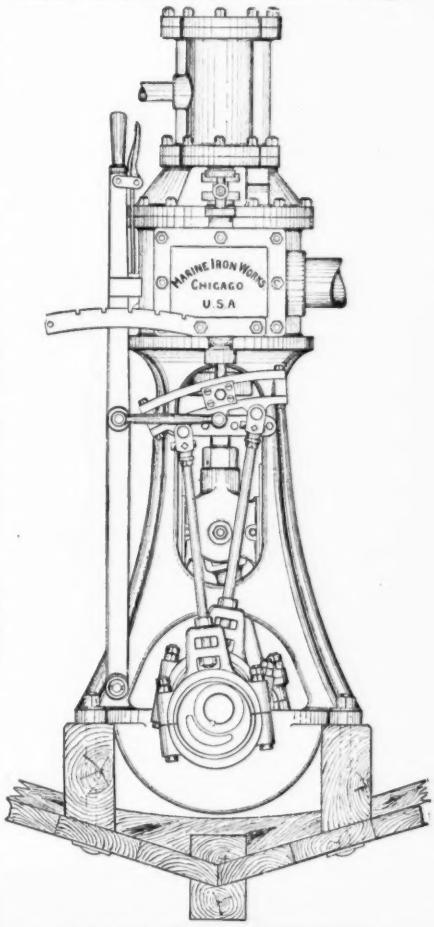
DIMENSIONS.

No.	Diameter of Cylinders.	Stroke.	Height above timbers.	Diameter above Crank Shaft.	Crank-pin.
1	5½—10	5	5 ft.	2¾ in.	2¾×3
2	7 —12	8	5 ft. 6 in.	4 in.	4 ×5
3	8 —14	10	5 ft. 10 in.	4½ in.	4½×5½

For general work and with steam pressures of 140 to 160 lbs., the best proportions for propeller wheels on these engines are as follows:

Engine No.	Diameter of Wheel.	Pitch of Wheel.
1	34 to 37 inches.	48 to 54 inches.
2	44 to 46 "	56 to 60 "
3	52 to 56 "	66 to 72 "

The larger wheels (in diameter) for towing. A line of sectional blade propeller wheels is supplied by the works named above, in sizes ranging from 48 inches to 72 inches diameter; the "pitch" or "lead" of these is being adjustable to meet the *exact* requirements of each particular case, and one hub may be fitted with two sets of blades; one set for heavy work, such as towing,



STEEPLE COMPOUND MARINE ENGINE.

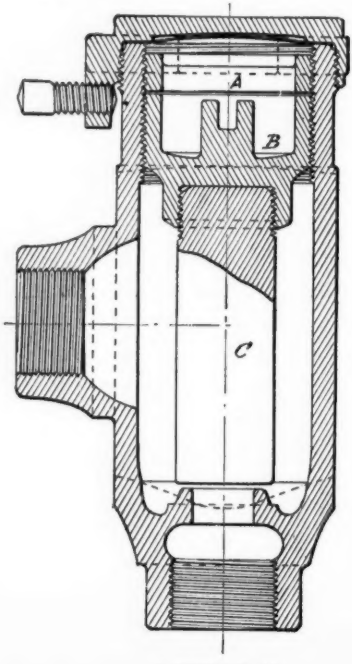
freighting, etc., the other for speed, or cruising. This convenient arrangement, for many boats, more than offsets the higher first cost of such wheels.

Facility of access to working parts, stuffing boxes and lubricating devices, and rigidity of framework are features of the design. The high-pressure cylinder has a balanced piston valve; the low-pressure, a plain slide valve. The crank-shaft is of hammered steel, and counterbalanced. All parts subject to wear are constructed so that wear can be taken up.

A Simple Trap.

WE illustrate what is called by the makers, for the sake of a name, the "Diamond" trap. This is a simple and inexpensive device specially designed for automatically discharging the water of condensation in car heating, heaters in rubber works, and similar places where, say, 500 or 1000 feet of ¾-in. or 1-in. pipe are to be taken care of. The steam is to be connected to the opening, *D*, and the discharge takes place at outlet, *E*.

To adjust the valve for service steam is first allowed to blow through until the entire valve is thoroughly heated. The head, *B*, with the expanding plug, *C*, is then screwed down and fastens the plug permanently in position, and the outer cap is screwed down tightly over all. While the chamber is filled with steam the valve will remain closed, but as the water collects in it, the temperature will fall, the plug, *C*, will contract, being made of special material for this service, and the water will flow out until the steam arrives again, when the valve will instantly close. This simple and useful trap is made by Jenkins Brothers, 71 John St., New York.



A SIMPLE TRAP.

Electric Motors on the Brooklyn Bridge.

THE first official exhibition of electricity as applied to the switching of the cars on the Brooklyn Bridge was made February 8, at 11 A. M., in the presence of President Howell, Vice-President J. Seaver Page, Trustees Keeney and Henriques, ex-Mayor Schieren, and other prominent citizens and railroad men. The motor car was coupled to three of the ordinary passenger cars, and the complete train of four cars was switched by the motors from the incoming to the outgoing platforms and thence to the cable sheaves several times. The car was then taken over the complete bridge circuit twice. Complete satisfaction was expressed by the president and by Chief Engineer C. C. Martin, at the manner in which the work was performed.

Experiment is not a function of municipal bodies, such as that governing the operation of the bridge, and, though the authorities recognized fully all the possible advantages, they hesitated to apply electricity to bridge traction service, until it was made certain by experiments elsewhere that, if applied, it would work without a hitch. The success achieved by electric motors in heavy service on eastern, western, and southern roads has given the needed assurance.

In asking propositions for the supply of electrical equipment, two companies only were considered,—*viz.*, the General Electric Company (which had already equipped the West Side Elevated Railroad at Chicago, the Nantasket Beach division of the New York, New Haven, and Hartford R. R., and the Baltimore and Ohio main line, with motors for heavy traction work), and of the Westinghouse Company. The latter declined, but the General Electric Company responded, offering to fully equip one car, operate it for thirty days, and at the end of that time, if the results were not satisfactory, restore the car to its original condition and bear the cost of the experiment. If the plan adopted proves economical, a certain number of cars will be equipped.

CIVIL ENGINEERING

Railroad Engineering; Bridge Engineering; Hydraulic Engineering; Municipal Engineering; Mechanics; Mechanical Drawing; Electricity; Architecture; Architectural Drawing and Designing; Steam Engineering (Stationary, Locomotive or Marine); Plumbing and Heating; Coal and Metal Mining; Prospecting, and the English Branches.

Engineers can employ idle time in reviewing or in mastering other branches. A Scholarship entitles the holder to tuition, until he is qualified to receive the Diploma, no matter how long it may take nor how often it may be necessary to review. Students can interrupt their studies and change their residences. Scholarships are not forfeited upon failure to pay installments promptly. Each student is a class by himself, and has the advantage of individual direction by a competent instructor. Students make rapid progress in learning to Draw and Letter. Specially prepared Instruction and Question Papers, Condensed, Simplified. All representations may be relied upon.

Send for Free Circular and Book of Testimonials, stating the subject you wish to study, to

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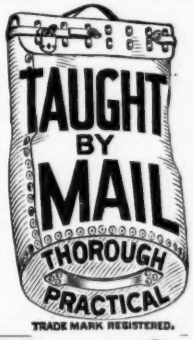

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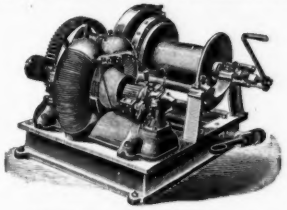

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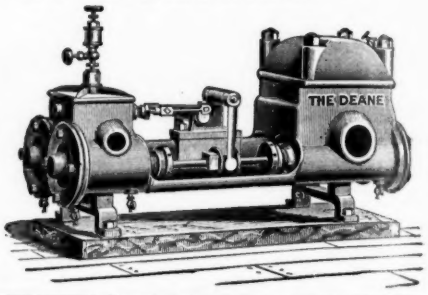

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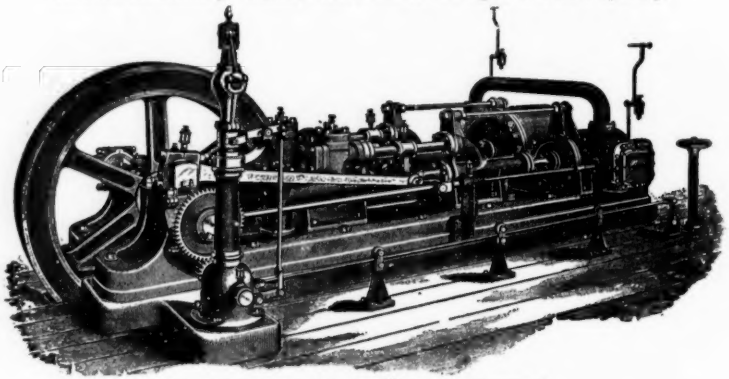

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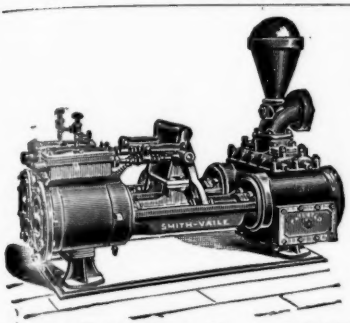

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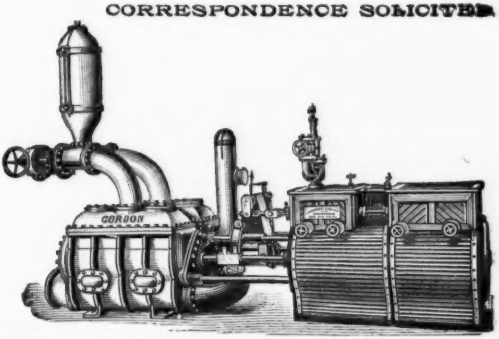

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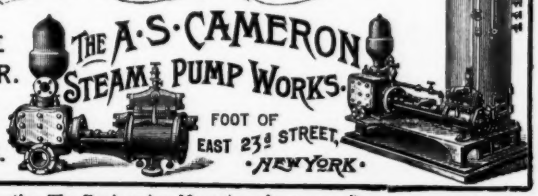

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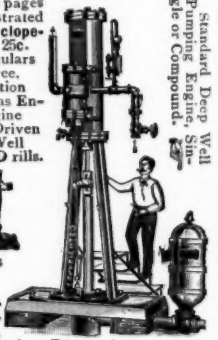

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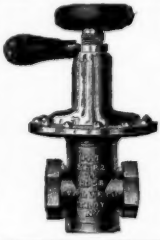

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